# INDUSTRIAL MINERALS OF THE PACIFIC NORTHWEST

BY A. J. KAUFFMAN, JR.

Information Circular 7641

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by

A. J. Kauffman, Jr.[1/]

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## SUMMARY

This inventory of the industrial mineral resources of the Pacific Northwest indicates that each of the States comprising this great region annually produces nonmetallic materials valued at many million dollars. Commodities or their products that have a large, localized market predominate. These include Portland cement, sand and gravel, stone, clay, and lime.

The region's output of magnesite, vermiculite, pumice, and diatomaceous earth is outstanding. The magnesite deposits of Stevens County, Wash., are the largest and most important in this country. Most of the domestic vermiculite production is obtained from deposits in Lincoln County, Mont. Oregon and Idaho rank third and fourth, respectively, as domestic pumice producers. Production data for diatomaceous earth show Oregon second and Washington fourth among the producing States.

The enormous phosphate-rock deposits of Idaho and Montana have yielded substantial tonnages of the raw material. Probably more important, however, is their potential value, since it is reported that 85 percent of our phosphate-rock reserves are in Idaho. Vast deposits of barite and gypsum are known in Idaho also, the barite deposits ranking with the largest found west of the Mississippi River.

Gem materials, although classed as semiprecious, are found abundantly distributed in Oregon, Washington, and Montana. The "thunder eggs" of eastern Oregon have attained national recognition.

The talc and graphite deposits of Washington and Montana are potentially commercial, even though production has been small to date. Some of the graphite produced in Montana compares favorably with that imported from Ceylon.

Potentially important deposits of garnet, corundum, asbestos, feldspar, gypsum, and the sillimanite group of minerals are known in Montana. In Washington, deposits of olivine, dolomite, and massive serpentine have commercial possibilities. Several deposits of graphite in Idaho are of commercial grade.

## INTRODUCTION

The Pacific Northwest is a name symbolizing the regional unity of the States of Oregon, Washington, Idaho, and Montana. Despite marked physical diversities of the various parts of the region, similarities in economic activities and problems have overcome the obstacles to regional unity. The Pacific Northwest is in the pioneer stage of development compared with other sections of the United States.



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The economy of this region is based upon exploitation of its natural resources, including agricultural land, forests, water power, and minerals. In the past, mineral development has been restricted by comparatively small demand, distance from markets, high freight rates, and local industrialization. It is reasonable to expect that, since the region is self-sufficient in many minerals, the order of the future will be expansion. The population is steadily increasing and with it will come new demands for raw materials, as well as fabricated products, and industrialization will proceed.

A wide variety of minerals occurs in the area; however, the traditional interest in the metallic-mineral resources has partly obscured the potentiality of its nonmetallic or industrial minerals. As a consequence, information as to quantity, quality, location, and other critical economic factors of these industrial minerals is inadequate. It is hoped that this compilation will emphasize the inadequacy of the information available and consequently stimulate enough interest on the part of those concerned to contribute the facts so that future inventories may be more complete.

This account shall be concerned solely with the industrial minerals of this great region. An attempt will be made to present an inventory of the industrial-mineral resources, both proved and potential, of the area; however, omissions are inevitable because of incomplete data. The author has examined all available literature on the subject and has had the personal cooperation of many authorities in the field.

Industrial minerals are the basis of a large, important group of industries, including building materials, sold as dimension stone, concrete aggregate, cement, brick, sturctural tile, mortars, plasters and interior finishes, sewer and drain tile, floor tile, and terra cotta. They enter into the manufacture of building and electrical insulation and are the principal raw materials for glass and enamels. They are the fluxes and refractories for metallurgical and other high-temperature furnace operations, and the raw materials for natural and artificial abrasives; they are used as mineral fillers and mineral pigments in a variety of manufactured products. They also have many other industrial uses.

ACKNOWLEDGMENTS

Acknowledgment of individual references would make the report too cumbersome. Many sources have been freely drawn upon, and most of them will be found in the bibliography. A few sources have furnished the bulk of the information and deserve special mention. These include: Industrial Minerals and Rocks (American Institute of Mining and Metallurgical Engineers), Economic Mineral Deposits (Alan M. Bateman), Minerals Yearbook (Bureau of Mines staff), Nonmetallic Minerals (R.B. Ladoo and W. M. Meyers, McGraw-Hill, 2d ed., 1951); Ore.-Bin (Oregon State Department of Geology and Mineral Industries), and the Raw Materials Survey News Letter (Raw Materials Survey, Portland, Oreg.). Reports of the Bonneville Power Administration and the various State departments of geology and mining also were used. Special reference should be made to the excellent report by Grant M. Valentine, Inventory of Washington Minerals, Part I, Nonmetallic Minerals. The reader is referred to the above reports should more-detailed information be desired on any industrial mineral.



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## INDUSTRIAL MINERALS OF PACIFIC NORTHWEST

The interest in industrial minerals in the Pacific Northwest has been attested to by the Industrial Mineral Conferences, sponsored by the American Institute of Mining and Metallurgical Engineers, held in Portland, 1948; Spokane, 1949; and Seattle, 1950. Interesting and informative papers were delivered, and the meetings were attended enthusiastically.

Oregon annually produces industrial minerals valued at about $10,120,000. Portland cement or sand and gravel usually lead in value of output, followed by stone, clay and clay products, lime, pumice, perlite, and silica.

In recent years, Washington has produced industrial minerals and their products valued between $24,000,000 and $31,500,000 annually. Portland cement leads in value of production, followed by coal, sand and gravel, stone, clay and clay products, magnesite, and some 16 additional materials. Coal is not being included in this report.

The annual value of the industrial minerals produced in Idaho is about $6,500,000. The materials and the order of their importance are the same as for Oregon and Washington, with phosphate rock and garnet added.

Montana has known deposits of 30 to 40 industrial minerals and rocks, but development of these deposits has been overshadowed by the production of metals and fuels; however, past production has been valued at $100,000,000.

### Abrasives

Abrasives are materials having physical properties that qualify them for use as abrading, scouring, grinding, and polishing agents. They may be either natural or artificial, and their desirable properties include hardness, toughness, character of cleavage or fracture, uniformity of grain size or shape, and purity. Natural abrasives include rocks and minerals used without chemical or physical change other than grinding and possibly bonding. Artificial abrasives are made from minerals or metals by some heat or chemical process.

Probably no one abrasive is suited for all applications. The particular work dictates the type of abrasive to be used.

Abrasive grains include quartz, sand, garnet, corundum, emery, aluminum oxide, boron carbide, and silicon carbide. Fine-grained powders include rouge, tin oxide, chromium oxide, cerium oxide, rottenstone, pumicite, pumice, diatomite, tripoli, ground silica, clay, whiting, and feldspar. These abrasive grains can be used as loose grains or can be pressed or molded into bonded abrasives or cemented to paper or cloth to form coated abrasives.

A large tonnage of diatomite and pumice is produced in the Pacific Northwest. Most of it, however, is used for purposes other than abrasives and will be treated elsewhere.



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Garnet

Oregon. - Garnet has been reported from Curry, Coos, Baker, Grant, and Wallowa Counties. It is a minor constituent of the Oregon black sands but is not being produced at present.

Washington. - Garnet occurrences have been reported in Snohomish, King, Okanogan, Stevens, Skagit, Ferry, and Chelan Counties.

Okanogan County. - The Magnetic Mining Co. is crushing massive garnet from its Buckhorn Mountain deposit. The commercial possibilities of the Moore and Texas Creek deposits have not been thoroughly investigated.

Skagit County. - The Cascade deposit is inaccessible at present. A deposit known as the Last Chance mine has been reported.

Snohomish County. - Garnet deposits 3 miles southeast of Index and in the vicinity of Vesper Peak and Barclay Creek have been reported.

King County. - Commercial deposits are known at Guye Peak and Denny Mountain.

Chelan County. - Garnet of undetermined quality occurs in large quantities near Gaynor.

Stevens County. - The Orient gneiss along the Kettle River contains commercial quantities of garnet. Occurrences at the Magma mine, Bon Air School, and Deer Trail Monitor mine have been reported.

Ferry County. - The Midnight mine is being investigated.

Idaho. - Garnet has been reported in Clearwater, Nez Perce, Boise, Adams, Latah, Idaho, Lemhi, Shoshone, Custer, Cassia, and Benewah Counties.

Benewah County. - The Garnet Mines, Inc., and the Idaho Garnet Abrasive Co. are both producing from the Emerald Creek area near Fernwood.

Idaho County. - Rare Earths, Inc., of McCall intends to produce garnet as a byproduct of their monazite concentration operation.

Montana. - Garnet deposits are known in Madison and Dillon Counties.

Dillon County. - In southwestern Montana, along Sweetwater Road east of the Keystone talc mine, a large garnet deposit occurs in metamorphic rocks. The total quantity of garnet is enormous, but the deposits are not of commercial significance because of their distance from markets and competition from artificial abrasives.

Corundum

Oregon. - There are no reported occurrences of corundum in Oregon.



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Washington. - Corundum is not found commercially in Washington; however, an occurrence of corundum crystals of some type has been reported on Turk Creek, Okanogan County.

Idaho. - Corundum has been reported from Lewis, Clearwater, Idaho, Adams, Boise, and Custer Counties.

Montana. - Corundum has been reported from Lewis and Clark, Deer Lodge, Beaverhead, Granite, Powell, Broadwater, Judith Basin, Madison, and Gallatin Counties.

Gallatin County. - During World War II, the American Abrasive Co. and several agencies of the Federal Government developed a deposit 17 miles southwest of Bozeman near Gallatin Gateway. Other deposits have been found 12 miles southwest of Bozeman.

Beaverhead County. - The Camp Creek corundum deposit, 1 mile southwest of the Crystal Graphite mine, apparently is high grade but limited in quantity. The Bear Trap deposit, 12 miles southeast of Dillon, is commercial grade.

Deer Lodge County. - The Dry Cottonwood Creek deposit contains corundum.

Granite County. - Occurrences known as the Rock Creek and Quartz Creek deposits have been reported.

Lewis and Clark County. - Deposits at Magpie Gulch, Eldorado Bar, and placers along the Missouri River are potential sources.

Madison County. - The commercial possibilities of the Norris deposit are not known.

Silica Abrasives

Washington. - Commercial quantities of pure quartz are found in eastern Washington near Spokane (Spokane County), in central Washington near Wenatchee (Chelan County), and at Marblemount (Skagit County) in northwest Washington. Other deposits are known, but their potentialities have not been proved.

Quartzite occurs in commercial quantities in the Chewelah district of Stevens County.

A sandstone deposit has been reported near Tacoma, King County, but its suitability as a sandstone abrasive is not known.

There is reported production of pulpstone from King County. Grinding pebbles are marketed by the Mineral Products Co. of Seattle.

No natural-abrasive plants are operating in the Pacific Northwest.



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## Artificial Abrasives

Silicon carbide is being produced at the Carborundum Co. plant at Vancouver, Wash., and there is the possibility of a good market in the Pacific Northwest.

## Asbestos

The fibrous varieties of a number of minerals are grouped under the general term "asbestos." It is unique among minerals in that it can be separated into fine, flexible fibers, is fire- and acid-resistant, and is a good heat and electrical insulator.

The most abundant and useful type of asbestos is chrysotile, a hydrous magnesian silicate belonging to the serpentine group of minerals. The other types all belong to the amphibole group, including crocidolite, anthophyllite, amosite, and tremolite-actinolite.

Chrysotile usually occurs as cross fibers (fibers at right angles to vein walls) with a maximum length of about 2 to 3 inches. These fibers can be spun into thread and woven into cloth. Chrysotile withstands relatively high temperatures, although at about 450° C. it loses water and becomes brittle. It is more readily attacked by acids than the other types.

Crocidolite fuses at a low temperature but is more resistant to acid and alkali attack. Its spinning qualities are inferior to chrysotile, but it has a higher dielectric constant.

The fibers of amosite are stronger and longer than chrysotile, but they are harsh and do not spin well. It is superior to crocidolite in withstanding heat but is not as resistant to acid and alkali attack.

Tremolite-actinolite and anthophyllite resist acid attack but lack tensile strength and are not good for weaving. They are especially desirable for filtration.

The long-fiber varieties are spun into yarn and woven into cloth and used for brake linings and fireproof articles of clothing. They also are used for special packing, gaskets, insulating materials, and asbestos-cement products. Medium-length fibers are mixed with Portland cement to make shingles, corrugated and flat sheets, and pipe. Short fibers compounded with various resins are being used to a large extent to manufacture molded articles.

Asbestos filter pads may eliminate pasteurization of low-alcohol fruit juices. Asbestos filters sterilize by eliminating fermentation yeasts and bacteria by means of the natural but unusual composition of asbestos. The natural aroma, taste, color, and nutritive properties are retained.

## Oregon

Deposits are known in Grant, Jackson, Baker, Lake, Malheur, Lane, Coos, Josephine, Douglas, Crook, and Wheeler Counties.



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Baker County. - Occurrences are known in the Pine Creek and upper Burnt River areas. The deposits on Pine Creek, 20 miles south of Baker, are mainly anthophyllite with some chrysotile. The Buttercups Mines, Inc., in the upper Burnt Creek area has tremolite and massive soapstone.

Grant County. - The Oregon asbestos mine in the Canyon district, about 5 miles up Beaver Creek from Mount Vernon, was active for a short period about 1916. A fine grade of chrysotile was produced. The Asbestos Corp. of Canada recently explored a deposit 5 miles north of Mount Vernon by diamond drilling and trenching. It also examined deposits on Butte Creek near the Middle Fork of the John Day River.

Jackson County. - H. L. Wadell, Grants Pass, Oreg., under the name Oregon Asbestos & Mining Co., has leased the Liberty mine on Cedar Springs Mountain (Gold Hill area) in northern Jackson County. It is a deposit of white tremolite asbestos.

Lake County. - Chrysotile is reported south of Lakeview in the Pine Creek mining area.

Malheur County. - Chrysotile is reported near Ontario and Watson.

Washington

Asbestos has been reported from Skagit, Snohomish, Whatcom, Chelan, Ferry, Okanogan, and Stevens Counties.

Skagit County. - The Asbestos-Talc Products Co. mined a deposit at Burlington. The ground material was mixed with imported asbestos and used for special cements. A deposit near Hamilton, across the Skagit River from Skagit, has produced and shipped a small tonnage. The Scott deposit at Skagit has possible commercial value.

Okanogan County. - Amphibole asbestos from a deposit at Alta Lake, 6 miles southwest of Pateros was formerly shipped to the Asbestomine Co. in Wenatchee for manufacturing cold-water paint.

Chelan County. - The Icicle Creek deposit near Leavenworth is being developed. Other deposits in Chelan County that probably will be investigated include: Chumstick Mountain deposit; Goose Creek deposit (serpentine); a deposit north of Monitor; Swakane deposit (pyrophyllite); and a serpentine deposit 30 miles north of Leavenworth.

Stevens County. - Deposits at Stranger Creek (fibrous tremolite) and Boundry Butts (tremolite) have been reported.

Snohomish County. - The Asbestos Group deposit (talcose-asbestos) 3 miles northwest of Silverton is being developed.

Idaho

Occurrences have been reported in Teton, Idaho, Madison, Fremont, and Clearwater Counties.



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Idaho County. - Extensive deposits of amphibole asbestos (anthophyllite) have been examined near Kamiah. The Industrial Research Division, Washington State College, is conducting a research investigation using this material.

Clearwater County. - Amphibole asbestos deposits have been examined. Development of these deposits and those of Idaho County has been slow because of small demand and high freight rates.

Deposits of chrysotile have been examined in Fremont, Teton, and Idaho Counties.

Montana

Asbestos minerals have been reported from Lincoln, Stillwater, Lewis and Clark, Deer Lodge, Broadwater, Madison, and Gallatin Counties.

Small amounts of asbestos have been marketed from time to time, but known deposits have not proved successful as yet.

Madison County. - An occurrence of short-fiber serpentine asbestos (chrysotile), 50 miles south of Ennis at Cliff Lake, was partly developed, and a small amount was milled, but the enterprise was not a commercial success.

Gallatin County. - Short-fiber amphibole asbestos has been produced from the Karst mine near the Karst Kamp on the Gallatin River, 35 miles south of Bozeman. In 1938 the Montana Asbestos Co. purchased the property from the Karstolite Co. and operated it for 2 years. It was closed until 1947 when the Interstate Products Co. opened it for commercial development.

Lincoln County. - Large quantities of amphibole asbestos are known in the Rainey Creek area, 7 miles northwest of Libby. None has been produced commercially.

## Barite

Barite or, as it is sometime called, heavy spar or barytos, is the most common barium-bearing mineral produced commercially. The occurrence of barite is widespread and the individual deposits may vary widely in quality and size.

Barite is sold in crude lumps, in jig or flotation concentrates, and in the ground condition. Its chief use is in oil-well drilling muds to provide a dense slurry that will withhold abnormal gas pressure during drilling. It also is used to produce lithopone, barium chemicals, and glass. Titanium dioxide is replacing a large part of the lithopone used as a white pigment in paints and other products. There are no lithopone or barium chemical plants in the Pacific Northwest. Other uses of barium include: Filler in oilcloth, linoleum, and rubber; X-ray-proof plaster and concrete; and brake linings.



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Oregon

Barite has been reported from Baker, Douglas, Josephine, Lane, and Wallowa Counties.

Baker County. - Barite is found at the Magpie mine in the Rock Creek mining district, 3 miles from Baines. An occurrence is known east of Clover Creek on the property of the Clover Creek Copper Co.

Douglas County. - The Prospect mine has been operated by E. M. Remfrew of Myrtle Creek.

Josephine County. - In 1946 the American Smelting & Refining Co. rehabilitated the Almeda mine on the north bank of the Rogue River, 26 miles below Grants Pass. Barite is associated with the copper ore.

Washington

Barite deposits are known in Mason, Stevens, Okanogan, Ferry, and Pend Oreille Counties.

Stevens County. - The Copper Butte mine produced barite in 1942 that was shipped to the Sunshine Mining Co., Kellogg, Idaho. The Shallenberger deposit was mined in 1938. Other deposits in Stevens County, which probably will be examined, include: Iron Cap prospect; Bruce Creek deposit; Oman deposit; Eagle Mountain deposit; Inklers Point deposit; and Red Marble deposit. Many of these deposits have not been developed as yet because of their distance from existing markets.

Mason County. - The Maple Creek deposit on the Hamma Hamma River has not been examined thoroughly.

Idaho

Deposits of barite have been reported in Adams, Custer, Blaine, Clark, and Cassia Counties.

Blaine County. - Some of the largest high-grade deposits west of the Mississippi River occur in the Hailey, Deer Creek, and Muldoon sections of this county. The J. R. Simplot Co. is producing barite from the Sun Valley barite mine near Hailey. The material is ground at the company plant near Pocatello.

Montana

Occurrences of barite have been reported in Lincoln, Missoula, Beaverhead, Phillips, Carter, Carbon, and Musselshell Counties.

Lincoln County. - Some barite reportedly has been shipped from the vicinity of Libby.



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Other minor occurrences are known in Carbon County at Red Lodge, Missoula County at Missoula, and Carter County at Ekalaka. None of these has undergone extensive development.

## Bauxite

Bauxite is the principal ore of aluminum but is used also in the manufacture of artificial abrasives, in certain chemical industries, and in refractories and special cements. Discussion in this paper is confined to its nonmetallic uses.

Bauxite is fused with coke and iron in an electric furnace for 24 hours at 3,500° F. to form a sintered mass that is crushed and ground for abrasive use. It is marketed under such names as Alundum, Aloxite, etc. Aluminous refractories are more resistant to heat, abrasion, corrosion, and spalling than the ordinary fire-clay refractories. They are usually made by mixing the bauxite with a binder, pressing into forms, and baking. Mullite-type fused-alumina refractories are commonly cast directly from the melt. Aluminous cement is characterized by rapid-hardening properties and resistance to chemical action and heat.

### Oregon

Bauxite deposits are known in Columbia, Washington, Clackamas, Polk, and Marion Counties.

Columbia and Washington Counties. - Extensive deposits of low-grade bauxite occur 35 to 60 miles northwest of Portland.

Clackamas County. - A deposit of high-silica bauxite about 35 miles southeast of Portland shows possibility of being usable for purposes other than the production of alumina.

Marion County. - A high-grade deposit recently has been reported northeast of Mehama. Development has been insufficient, to date, to indicate its economic possibilities.

The Alcoa Mining Co. has made extensive surveys of the areas.

### Washington

Bauxite is only a recent discovery in Washington. The Aluminum Co. of America has proved extensive deposits of ferruginous bauxite in the Cameron Creek and Mill Creek areas of Cowlitz County.

### Idaho

No information available.

### Montana

No information available.



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## Cement Materials, Including Brick and Tile

Vast expansion of highway and building construction has created a great demand for cement, and the industry is now the sixth largest in value of output among American mineral industries.

Cement is essentially a mixture of limestone and clay or shale calcined to near fusion and ground to a fine powder. When this powder is mixed with water it becomes hard, either in air or under water. The use of cement dates back far into history. The Romans found that, by adding quicklime to the volcanic ash of Pozzuoli, a cement was formed that would set under water. They used it widely in construction and named it Pozzuolan cement. In more recent times (1756), an English engineer found that he could obtain a product with similar properties by calcining an impure limestone. This marked the beginning of the use of hydraulic cements.

Portland cement, so-called because of its similarity in appearance to Portland stone, a variety of limestone used extensively as a building stone in England, is manufactured by very exacting methods by passing a mixture of calcined limestone, clay, and water through a kiln. The calcined mass, after being ground to a fine powder, is ready for use. Gypsum is added to the clinker before grinding to the final product to control the setting rate of the cement. It prevents a quick set and insures the delivery of a uniform and dependable material.

Source materials are: (1) Cement rock, a low-magnesian clay containing limestone; (2) limestone; clay and sand are no longer objectionable impurities when used for manufacture of Portland cement; (3) other calcareous materials, such as marls, shell marls, recent shells, chalk, and calcium carbonate waste from manufacture of sodium carbonate; (4) clay and shale to bring alumina and silica content to desired level; (5) iron ore, calcined pyrite, and mill scale, added to make a cement that has a low heat of hydration.

The Mechanical Engineering Department at Oregon State College reported that at least two different volcanic-ash samples investigated had properties suitable for a source of Pozzuolanic material for use in massive concrete structures. It indicated that unprocessed volcanic ash as mined at Bend, Oreg., can replace about 30 percent of the cement used in large concrete structures without loss of strength.

Durisol, Inc., 420 Lexington Avenue, New York, N. Y., is interested in licensing a Pacific Northwest firm to make lightweight precast cement items using mineralized wood shavings as an aggregate material.

### Oregon

Most of the limestone produced in the State is used for manufacturing Portland cement. The most important producing counties are Baker, Polk, Josephine, Wallowa, and Douglas.

Baker County. - The Oregon Portland Cement Co. of Portland has a quarry and kiln at Lime, about 5 miles north of Huntington.



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Multnomah County. - Builders Concrete Products Co. and Gardner Concrete Block Co. operate in the county.

Josephine County. - The Pacific Portland Cement Co. of Gold Hill is operating a quarry on Marble Mountain, south of Wilderville. The kiln is at Gold Hill, Jackson County.

Polk County. - The Oregon Portland Cement Co. has a quarry at Dallas and a kiln at Oswego in Multnomah County.

The Smithwick Concrete Products Co. of Portland recently put a shale-bloating plant into full-scale operation. It is next to the company concrete-block plant in northwest Portland. The company is producing Haydite, a lightweight aggregate material made by expanding a marine shale quarried near Vernonia in Washington County. Haydite is a trade name used by the American Aggregate Co., Kansas City, Mo. The expanded material has low shrinkage, desirable acoustical and thermal properties, and an exceptionally high strength-weight ratio.

The Northwest Aggregate Co. plant near the Sunset Tunnel on Sunset Highway, 40 miles northwest of Portland, has been purchased by the Empire Building Materials Co. of Portland. It is producing Lite-Rock, an expanded shale similar to Haydite.

Some of the more important building-block manufacturers include:

Baker County. - Bilt-Rite Block Co., Baker-Union Concrete Products Co.

Deschutes County. - Deschutes Concrete Products Co.

Douglas County. - Chrystalite Tile Plant, Pre-Mix Concrete and Roseburg Concrete Products Co.

Jackson County. - Acme Block Co., Builders Supply Co., Conco Block Co., Eagle Flue Co., Hiatt & Karble, Ideal Block Co., Medford Concrete Construction Co., Savage Creek Block & Concrete Co., Triple A Block Co., and Valley Block Co.

Josephine County. - Concrete Products Co., V. R. Huffman Co.

Klamath County. - Chrystolite Products Co., Hodge Bros., L. P. Montgomery, and A. J. Tracy Co.

Lake County. - Concrete Products Co. and A. B. Seymour Co.

Lane County. - Creswell Concrete Block Co.

Malheur County. - Armco Drainage & Metal Products Co., Eastern Oregon Pipe Co., and Nyssa Tile & Pipe Co.

Marion County. - Boock Building Block Co., Mortarless Block Co., Oregon Gravel Co., Salem Concrete Pipe & Products Co., and 12th Street Block Co.



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Multnomah County. - Builders Concrete Products Co., Garner Concrete Block Co., Western Block Co., Columbia Brick Works, Sylvan Brick Co., and Manford Pate Co.

Polk County. - Ben Reimer Co.

Umatilla County. - Umatilla Building Materials.

Washington County. - McCormack Concrete Pipe Co. and Tigard Concrete Products, Inc.

Washington

Cement materials are produced in King, Whatcom, Stevens, Spokane, Skagit, Pierce, Lewis, Yakima, Clark, Okanogan, Snohomish, Chelan, San Juan, and Pend Oreille Counties.

King County. - The Northwestern Portland Cement Co. of Seattle has a quarry and kiln at Grotto. The Abrahamson Brick Co. of Seattle is operating a clay pit in the area. The Builders Brick Co. of Seattle is operating the Seattle pit. The Mutual Material Co. of Seattle is operating a plant and pit in the South Park area. The Seattle Brick & Tile Co. has a pit and plant in the city. The Northwest Haydite Co. is manufacturing Haydite from a shale obtained near Woodinville. The Washington Pottery Co. is operating in Seattle.

Whatcom County. - The Olympic Portland Cement Co., Ltd., of Bellingham is producing clay and limestone from the Kendall operation near Brennan. It has recently abandoned the Balfour and Olympic deposits. The Lynden Clay Products Co. obtains its raw material from the Emerson area.

Stevens County. - The Spokane Portland Cement Co. operates a clay pit near Evans and quarries at Northport, Marble, and Powell. The Washington Brick & Lime Co. of Spokane operates the A. B. pit and plant at Clayton. The Portland Cement Co. also operates in Spokane.

Spokane County. - The Spokane Portland Cement Co. operates a plant at Irvin. The Building Supplies Co. of Spokane is operating at Mead. The Washington Brick & Lime Co. of Spokane is operating the Freeman pit, Mica pit, and Mason pit near Verndale and a plant at Dishman.

Skagit County. - The Superior Portland Cement Co. of Seattle is operating a quarry and clay pit near Concrete.

Lewis County. - The Chehalis Brick & Tile Co. is operating a deposit north of Chehalis.

Yakima County. - The Granger Clay Products Co. has a pit and plant at Granger.

Clark County. - The Hidden Brick Co. of Vancouver is operating in the area, and the Muffet Brick & Tile Co. of Richfield has a deposit in the vicinity.



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Okanogan County. - The Oroville Brick Yard is operating near the city.

Snohomish County. - The Shaffer Brick & Tile Co. is operating its plant at Lowell.

Chelan County. - The Wenatchee Brick & Tile Co. is operating a plant near the city.

San Juan County. - The Olympic Portland Cement Co. is developing the Cowell deposit.

Pend Oreille County. - The Pacific Portland Cement Co. is developing the Box Canyon deposit.

Idaho

Very little information is available.

Latah County. - The following companies are operating: Idaho Firebrick & Clay Co.; Moscow Firebrick & Clay Co., Moscow; and the Idaho Ceramics Materials Co. of Troy.

Bannock County. - The Idaho Cement Co. is doubling the capacity of its Inkom plant.

Clearwater County. - The Washington - Idaho Lime Products Co. has a cement plant at Orofino.

Montana

Calcareous shales, clay, and limestone ingredients of portland cement exist in large quantities in the mountainous areas of Montana.

Carter County. - Large quantities of natural cement rock are found in the Arikaree and Niobrara formations near Ekalaka.

Hill County. - A large shale and limestone deposit, 5 miles south of Havre, could maintain a cement plant if other conditions were favorable.

Fergus County. - The Brick & Tile Co., near Lewiston, and plants at Trident and Hanover are producing.

Lewis and Clark County. - The Western Clay Manufacturing Co. is operating at Helena.

## Clay

Clay may be defined most simply as a hydrous aluminum silicate. The most evident property of most clays is their plasticity when wet. This plasticity permits the clay to be molded into many shapes and to retain these shapes after being fired. Mineralogically they belong to two main types - the kaolin group and the montmorillonite group.



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Clays may be classified as follows:

Kaolin represents a group of the hydrous aluminum silicates, the most abundant of which is kaolinite. The term is used widely commercially to include china clay.

China clay is the commercial variety of kaolin. It usually is necessary to purify this type before it is used. The washed clay is used in manufacturing high-grade products, such as white earthenware, porcelain of all kinds, paper and rubber fillers, and other products. It is highly refractory, but the plasticity is poor.

Ball clay is white or light-cream burning clay of high plasticity and bonding power that vitrifies to a dense, impervious body at comparatively low temperatures.

Fire clay is any clay that withstands high temperatures, particularly that which does not fuse at temperatures below 1,605° C. It is used in manufacturing fire brick or other refractories and often is used in architectural terra cotta and wall tile.

Face-brick clay is divided into three groups: (1) Red-burning; (2) white-burning; and (3) buff-burning. The color, plasticity, shrinkage, and vitrification must fall within certain general limits, depending upon the type of brick to be manufactured.

Common brick clay varies widely in composition and properties. It is usually high in fluxes and in most cases is red-burning. It should mold easily and develop hardness and strength at as low a firing temperature as possible without serious warping or cracking.

Sewer-pipe clays and shales, usually shale rather than clay, is used to make sewer pipe and paving brick.

Bentonite is a rock name given to an altered volcanic ash, which has as its principal constituent the clay mineral montmorillonite. It has high plasticity and bonding power and is used widely as a bonding medium in synthetic foundry sands and drilling mud. Most of the active group of bleaching clays are of bentonitic origin.

The Mellon Institute, Pittsburgh, Pa., has developed a new use for bentonite - mixed with a resin-forming organic polymer it forms a moisture-, chemical-, and heat-resisting plastic.

The use of bentonite, under the trade name Bentone, as a lubricating-grease base has been developed by the National Lead Co. interests at the Mellon Institute.

Oregon

Pits of common clay are widespread in occurrence, especially in the Willamette Valley.



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Deposits of refractory clays are known in Columbia, Yamhill, Clackamas, Marion, Lane, Douglas, Jackson, and Josephine Counties.

Columbia County. - The Sig Hansen deposit has quality and quantity that justify commercial development.

Yamhill County. - The clay of the Willamina Clay Products Co. is blended with other clays for various purposes.

Clackamas and Marion Counties. - The clays of the Molalla-Salem districts of these counties have been investigated extensively.

Lane County. - The Hobart Butte deposit contains a clay suitable for use as a refractory and also in whiteware, pottery, and possibly for paper and paint filling. At Black Butte the grade of the clay is variable. Preliminary investigations indicate that there is a lack of commercial quantities of high-grade fire clay equal to that found at Hobart Butte. In the Eugene district the Eugene Brick & Tile Plant and the Eugene Fire Clay Products Co. have experimented with various clays of the area.

Washington

Pits of common clay are widespread throughout the State, especially in King, Lewis, Whatcom, Skagit, Stevens, and Spokane Counties.

Refractory clay occurrences are known in Chelan, King, Whatcom, Stevens, Pierce, Lewis, Cowlitz, Klickitat, Douglas, Spokane, and Whitman Counties.

Chelan County. - The Squaw Saddle Mining & Milling Co. of Wenatchee is developing the Squaw Saddle deposit.

King County. - There are two operating properties - the Alcorn Bros. deposit and the Hammer Bluff deposit - operated by the Smith Bros. Silica Sand Co. Gladding, McBean & Co. has the Auburn, Harris, and Taylor properties. Occurrences known as the Green River (A) and Kanasket deposits have been reported.

Pierce County. - The LaGrande deposit formerly was operated by the Denny-Renton Clay & Coal Co. (Gladding, McBean & Co.).

Lewis County. - The commercial value of the Toledo deposit has not been determined.

Stevens County. - The A. B. pit is being worked by the Washington Brick & Lime Co.

Spokane County. - The Washington Brick & Lime Co. is operating the Freeman and Mica (A) deposits. Gladding, McBean & Co. is operating the Mica (B) deposit. Other occurrences, known as Connor pit, Milan deposit, Deadman Creek deposit, Bigelow Gulch, Fitzgerald place, Barnhart property, Conlan pit, California Creek, Wellsandt property, Nossley place, Thompson place, Lockwood, Manito Station, and Murphy Creek, have been reported.



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Whitman County. - The Cox pit formerly was worked.

Cowlitz County. - Gladding, McBean & Co. formerly operated the Cowlitz pit near Castle Rock.

Whatcom County. - Gladding, McBean & Co. is developing the Sumas Clay deposit.

Douglas County. - Gladding, McBean & Co. is operating the Wenatchee clay deposit.

Bentonite and fuller's earth have been reported from Benton, Pierce, Yakima, Kittitas, and Okanogan Counties.

Pierce County. - The Mineral Creek deposit is interstratified with perlite.

Yakima County. - The Tieton deposit is under development by Moore Bros., Naches. An occurrence known as the Hutchinson deposit has been reported.

Kittitas County. - The commercial possibilities of the fuller's earth deposit at East Roza have not been determined fully.

Okanogan County. - The Oroville deposit is being investigated.

Idaho

Clay for structural purposes is found in every county of Idaho. The best deposits are in Benewah, Kootenai, Cassia, Latah, Lewis, Idaho, Power, and Washington Counties.

There are extensive deposits of china clay in Latah County, most of which must be washed free of impurities before use. There are deposits of refractory and pottery clays in the county. The Olson deposit 8 miles northeast of Troy is being exploited and the Idaho Brick & Clay Co. is operating another deposit at Troy.

Bentonite occurs in commercial quantities in Clark and Custer Counties and has been reported in Cassia, Owyhee, Jerome, and Oneida Counties.

Montana

Deposits of common clay are widespread, and the Missoula and Kalispell Valleys of Missoula and Flathead Counties have extensive deposits of better-grade clays that could be used for terra cotta and ceramic wares; better-grade clay also is found in Fergus County.

Fergus County. - The Whiteware clay deposit (dickite) is found in the South Moccasin Mountains (Deihl Gulch) 3 miles northeast of Hanover. It is a pottery clay but may have value also for use in electrical porcelain, sanitary ware, and refractories.



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Bentonite, from a deposit 8 miles west of Lewiston, is used locally for lining irrigation ditches.

Low prices and competition from Wyoming and South Dakota deposits have discouraged extensive exploitation of Montana's bentonite deposits.

Extensive deposits of bentonite have been reported from the following localities:

| | |
|---|---|
| Valley County | - Near Glascow |
| Cascade County | - Near Great Falls |
| Rosebud County | - At Forsyth |
| Big Horn County | - Near Hardin |
| Carter County | - Southern portion |
| Silver Bow County | - West of Butte |
| Deer Lodge County | - East of Warm Springs |

## Diatomaceous Earth

Diatomaceous earth, or diatomite as it is sometimes called, is composed principally of the hydrous silica skeletons of diatoms, microscopic aquatic plants. Included usually are siliceous materials, such as sponge spicules, radiolaria, and other micro-organisms. Associated impurities are organic matter, quartz, carbonate, volcanic ash, and clay.

About 50 percent of the diatomite processed is used in filtration, 25 percent for insulation, and 25 percent for filler and miscellaneous uses.

**Filtration.** - Diatomite is used to filter and refine cane sugar; to manufacture beet-sugar; and to filter a host of other liquids.

**Insulation.** - Diatomite is used in the form of block, slab, brick, aggregate, powder, and cement. Its chief use is for industrial heat and cold insulation.

**Filler.** - Diatomite is used as a filler in battery-box and molded asphaltic compositions, roofing, waxes, paints, and varnishes.

**Miscellaneous.** - Diatomite is used as a mild abrasive, in glazes and enamels, and as a fine reactive form of silica for chemical processes. In the building industry, it is used as a constituent of concrete, mortar, cement, and plaster, and for lightweight building brick, block, wallboard, and panels. It is the preferred source of silica in the manufacture of lime-silica insulating and building materials.

The University of Idaho Agricultural Experiment Station is conducting research on a mixture of sawdust-diatomite clay as a possible source of lightweight aggregate. The mixture's proportion is 1 part cement, 1 part diatomite, 1 part clay, and 6 parts sawdust. It is fire-resistant, lightweight, high insulating properties, and has a 28-day compressive strength of 400 pounds.



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Oregon

Diatomite occurs in Baker, Clatsop, Crook, Deschutes, Grant, Harney, Jefferson, Klamath, Lake, Malheur, Sherman, Union, and Wheeler Counties.

Baker County. - Deposits are known near Clover Creek, Richland, and Durkee.

Clatsop County. - An occurrence is known on Brown's dairy farm.

Deschutes County. - The Great Lakes Carbon Corp. of New York is operating its quarry and plant at Lower Bridge on the Deschutes River near Terrebonne. The product is marketed under the trade name Dicalite. Development also has been reported by the Atomite or Oromite Corp. in the Lower Bridge area.

Grant County. - The Austin deposit, on the west slope of the Blue Mountains, has commercial possibilities.

Harney County. - Desposits are known in the Otis Basin area and near Burns.

Jefferson County. - Deposits occur on the Warm Springs Indian Reservation.

Klamath County. - Deposits are reported in the vicinity of Chiloquin, Klamath Falls, Poe Valley, Sprague Valley, Alkali Valley, and Olene and Klamath Lakes.

Lake County. - There is a deposit east of Silver Lake.

Malheur County. - Deposits are known in the Harper district and 25 miles North of Vale.

Union County. - Diatomite of excellent grade has been reported in the lake beds in the vicinity of Telocaset in the southern part of the county. A small amount reportedly has been produced and shipped to Walla Walla, Wash., for insulating material. There is also a deposit in the Indian Creek Valley area, 4-1/2 miles south of Elgin.

Washington

Occurrences of diatomite are known in Whatcom, Skagit, King, Kittitas, Snohomish, Jefferson, Yakima, Grant, Adams, Chelan, Benton, Klickitat, Kitsap, Lewis, Pierce, and Skamania Counties.

Kittitas County. - The Dicalite Division of Great Lakes Carbon Corp., Los Angeles, Calif., recently closed its plant at Kittitas and has purchased the Diatoms, Inc., operation at Bradley, Calif.

Grant County. - The Corliss Kaiser Co., Inc., of Yakima was reorganized and the name changed to the Kaiser Mining & Manufacturing Co. The company operates the State Products deposit. The Frankenhoff Corp. (formerly the Quincy Corp.) has acquired the assets and business of the Dia-Cousti-Lite Products Co. of Quincy. The name of the product marketed is Kenite.



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Diatomite deposits of commercial grade, or at least potentially commercial, are widespread in Washington. They may be tabulated as follows:

Adams County. - Wenzelberger deposit - past production.

Benton County. - Enough information is not available to evaluate the Kiona deposit.

Chelan County. - Morris deposit, 4 miles north of Fish Lake - being developed.

Grant County. - Webley and Grennell deposits; the latter was operated formerly by the Grennell Co.

Jefferson County. - Irondale deposit probably will be examined in detail.

King County. - Lake Mancock deposit is known to contain diatomite.

Kittitas County. - Denny, Clerf, East Roza, and West Roza have had past production.

Klickitat County. - Not enough information is available for evaluating the Satus Pass and Chapman Creek deposits. The Roosevelt deposit formerly was worked by the Miller Products Co., Portland, Oreg.

Lewis County. - The Morton deposit appears to be of commercial grade.

Pierce County. - The Parkland deposit is of commercial grade. Occurrences known as the Ray and Etonville deposits have been reported.

Skagit County. - The Nookachamp Creek deposit contains a commercial quantity of diatomite.

Skamania County. - Not enough information is available to evaluate the Stevenson deposit in the vicinity of Home Valley.

Snohomish County. - Deposits are known near Florence and Jim Creek.

Yakima County. - The Gleed, Maple Grove, and Sunnyside deposits have been reported.

Idaho

Diatomite has been reported from Owyhee, Camas, Nez Perce, Lewis, Washington, Gooding, Payette, Canyon, Idaho, Elmore, and Franklin Counties.

A small amount reportedly has been shipped from Elmore, Gooding, and Idaho Counties for sugar refining.

Canyon County. - The White Earth Products Co. of Caldwell is producing from an open pit near White Earth.



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Montana

Deposits of diatomite are known in Granite, Gallatin, and Broadwater Counties.

Broadwater County. - Two locations 5 miles northwest of Winston and 5 miles southeast of Townsend have been examined, but they are not developed enough for evaluation.

## Feldspar

The term "feldspar" is applied to a group of silicate minerals that have similar chemical and optical properties. They are aluminum silicates of sodium, potassium, and calcium. The sodium and potassium feldspars are the commercial varieties, the latter being the more important. Orthoclase and microcline are the potassium members and albite the sodium member of the group. Anorthite, the high-calcium member, is not desirable commercially. The feldspars seldom occur in commercial quantities as pure end members. The potassium feldspars usually are associated intimately with the sodium member, and the sodium feldspar usually is associated with the calcium member. Feldspars constitute about 50 percent of igneous rocks, but virtually all commercial production is confined to pegmatites. Recently, rocks such as alaskite, granite, aplite, and nepheline syenite, have been considered potential sources of the mineral.

The production of good china coincided with the discovery of the fluxing property of feldspar. Today virtually all burned-clay products use feldspar as a basic raw material. About two-thirds of all feldspar produced is used in making glass. Another important use is for enamels. It is used also as a mild abrasive in soaps, washing powders, and in dental porcelain.

Oregon

Feldspar has been reported from Jackson and Harney Counties. Systematic prospecting may disclose occurrences in Wallowa, Baker, and Union Counties.

Jackson County. - Feldspar is known in the Gold Hill and Ashland areas. It occurs with gold in the Sparks Mine.

Washington

Occurrences of feldspar have been reported in Yakima, Ferry, Okanogan, Skagit, Spokane, San Juan, Chelan, Pend Oreille, and Stevens Counties. None of the deposits is being worked on a commercial scale, but several show definite promise.

San Juan County. - Deposits on Orcas Island contain feldspar usable for the manufacture of high-grade porcelain.

Chelan County. - Occurrences known as the Wenatchee Lake, Chelan Tunnel, and Winesap deposits have been reported.



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Ferry County. - The Belcher mine is being investigated.

Stevens County. - A granite deposit at Waits Lake may yield a commercial-grade product after beneficiation.

Pend Oreille County. - A deposit known as the Coffin prospect has been reported.

Spokane County. - The Mica Peak and Fish Lake deposits have not been examined thoroughly.

Whitman County. - The Bald Butte deposit has commercial possibilities.

Idaho

Reports of feldspar occurrences have come from Bonner, Latah, Idaho, Adams, Valley, Boise, Custer, Fremont, and Cassia Counties.

Latah and Adams Counties. - Deposits of high-grade orthoclase have been examined. However, very little development has been done.

Washington County. - A large deposit of feldspar in a silica sand has been investigated near Weiser. It may be feasible to process it because of the simplicity of the operation.

Montana

Feldspar occurs in Lincoln, Fergus, and Madison Counties. Vast tonnages of feldspar occur in the pegmatites in the western part of the state, but freight rates and market conditions do not appear to justify development at this time.

## Fluorspar

Fluorspar is the industrial-mineral term for the mineral fluorite, calcium fluoride. It is a mineral of great industrial importance, and in times of national emergency many very necessary manufacturing processes would be handicapped without it.

About 50 percent of the fluorspar produced is used in the basic open-hearth process for steel making. It facilitates fusion and the transfer of objectionable impurities, such as sulfur and phosphorus, into the slag and also gives fluidity to the slag. It is used also to make hydrofluoric acid and is employed by the aluminum industry to make synthetic cryolite. The glass and enamel industry also uses it. It has other miscellaneous uses, including a refrigerator fluid (Freon 12) and a carrier for certain insecticides (Aerosol).

Most of the fluorspar produced in the Pacific Northwest is obtained as a byproduct from base-metal and/or precious-metal operations.



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Oregon

No commercial occurrences of fluorspar have been reported. There is an occurrence on the property of the Green or Gem group, 3 miles from Wallowa Lake, Wallowa County.

Washington

Fluorspar has been reported from Chelan, Snohomish, Okanogan, Ferry, and Stevens Counties.

Ferry County. - A small vein near Keller, in the southern part of the county, was operated in 1908. The Western Minerals Co. operated the Mitchem mine near Keller and set up a mill in 1945. The mine is under development. Some production comes from the Zella M mine as a byproduct. Possible production is listed from the American Flag mine.

Snohomish County. - The Ethel Consolidated Mining Co. is producing fluorspar as a byproduct from its copper operation.

Okanogan County. - The Ramore Mining Co. and the Apache claim are producing fluorspar as a byproduct of their operations.

Stevens County. - The Frisco Standard mine and the Coyote prospect are producing the mineral as a byproduct. A deposit associated with molybdenite at Phalen Lake probably will be examined in more detail. The Germania mine is producing fluorspar as a byproduct of its tungsten operation.

Idaho

Occurrences of fluorspar have been reported from Lemhi, Clearwater, Idaho, Valley, Shoshone, Custer, Butte, Camas, and Owyhee Counties.

Shoshone County. - The Coeur D'Alene Extension Mines, Inc., of Wallace, Idaho, produces fluorspar as a byproduct of its lead-silver operations.

Lemhi County. - The Big Lead property near Meyers Cove is under development. Fluorspar is abundant in this area, and some was produced during World War II.

Custer County. - The Pacific mine of the Swigert Mining Co. also is under development.

Much of the Idaho fluorspar is remote from transportation.

Montana

Fluorspar has been reported from Jefferson, Lincoln, Powell, Granite, Ravalli, Deer Lodge, Lewis and Clark, Silver Bow, Judith Basin, Chouteau, Mineral and Fergus Counties.

Mineral County. - The Coeur d'Alene Extension Mines, Inc., of Wallace, Idaho, operated a deposit near Superior. The Riverside Copper Mining Co.,



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also of Wallace, Idaho, sublet a group of claims in this same area. The Superior Fluorspar Corp. is developing a property near Superior.

Liberty County. - The fluorspar associated with a silver ore from the Malvina claim was investigated by the Bureau of Mines.

Ravalli County. - The Crystal Mountain prospect, recently investigated by the Bureau of Mines, seems to be commercial in grade and extent.

## Gem Materials

Gem materials or gem stones are minerals or rocks having special physical properties that make them desirable for personal adornment and decorative purposes. They are divided into precious and semiprecious varieties. With the possible exception of sapphire, the gem stones found in the Pacific Northwest may be classified as semiprecious. Interest in lapidary techniques as a hobby and as a business is steadily increasing, but, in addition to their use in jewelry, some gem stones find other uses, such as for watch jewels, as a base for ultramarine, in optical equipment, and for mortars, pestles, and balance bearings.

### Oregon

Gem material of some type suitable for lapidary cutting can be found in almost any county. The agate and thunder eggs (chalcedony-filled nodules) of eastern Oregon are widely known.

Morrow County. - An outstanding deposit of opal is found at Opal Butte.

Harney, Baker, Jefferson, and Wasco Counties. - The very popular thunder eggs are found in abundance.

Linn County. - Known for its petrified wood, especially in the Sweet Home area.

Lake County. - Good specimens of sunstone (feldspar) have been found in the central part of the county.

Jackson and Josephine Counties. - Grossularite garnet is found in different colors. The green variety is sometimes called Oregon jade.

Lake County. - Iridescent obsidian is found at Glass Buttes.

### Washington

Gem materials are found in Clallam, Skagit, Jefferson, Pierce, Thurston, Lewis, Cowlitz, Skamania, Grays Harbor, Kittitas, Douglas, Grant, Yakima, Franklin, Ferry, Klickitat, Okanogan, Stevens, Pend Oreille, Chelan, King, and Lincoln Counties.

Clallam County. - Spherulitic jasper occurs along the west coast of the Olympic Peninsula near the mouth of the Quillayute River. Agate has been found on Agate Beach west of Crescent Bay on the Strait of Juan de Fuca.



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Skagit County. - A ferrous anthophyllite that is somewhat serpentinized (has been called nephrite jade and jadeite) occurs on the James Stephens property 5 miles east of Sedro Wooley and is mined by the Northwest Tale & Magnesium Co.

Pierce County. - Quartz crystals with amethystine tips have been found on the Siegmund ranch, 1 mile east of Clay City.

Thurston-Lewis County area. - Agate and chalcedony occur in the Toro coal-mining district along the upper Newaukum River.

Cowlitz County. - Agate, jasper, and highly colored petrified wood occur in the area of Silver Lake.

Skamania County. - Opal occurs in the Wind River area. Chalcedony is found 4 miles northwest of Stevenson and amethyst at the Rainbow prospect 2-1/2 miles northeast of Washougal.

Kittitas County. - Blue chalcedony is found at Horse Canyon, 1 or 2 miles south of Virden. Opalized logs and log fragments are found in the Ginkgo Petrified Forest State Park. No collecting is allowed because it is a State park. Agate and onyx agate are found in the Redtop-Cle Elum Lake area and at Squaw Creek, 10 miles east of the Yakima River.

Douglas County. - Fire opal occurs in the Moses Coulee area.

Grant County. - Opalized wood is found along the summit of Saddle Mountain between Othello and Beverly.

Yakima County. - Red and maroon jasper occurs in the vicinity of Yakima. Petrified wood is found at Barrel Springs and along the Sunnyside-White Bluffs road.

Franklin County. - Agate occurs in the Ringold formation along the Columbia River, 16 miles from Pasco.

Klickitat County. - Opalized wood is found in the Roosevelt area.

Okanogan County. - Thulite, used for brooches and fireplace facings, occurs in the Turk Creek area. Green garnet and epidote occur in the Roosevelt mine. Turquoise is found in the Nespelem district, and quartz crystal occurs in the Early Winters Creek and Toroda Creek areas.

Stevens County. - A veinlet of thulite occurs on the Smoky Bullion property.

Pend Oreille County. - Thulite is found at Timber Mountain and amethyst at the Ries Mining property.

Lincoln County. - Fire opal occurs near Mondovi.

Whitman County. - Past production of precious opal has been reported from a deposit 3 miles east of Whelan Grange. Smoky quartz is found in a sand pit near Calton and amethystine quartz in Ringo Hills west of Ringo Station.



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Chelan County. - Mexican or travertine onyx is found on the Davenport property. Quartz crystal has been reported at the Crown Point mine.

Ferry County. - Amethyst occurs 15 miles northeast of Republic.

Grays Harbor County. - Agate is found along the ocean coast and west coast of the Olympic Peninsula.

Jefferson County. - Quartz crystal occurs in the Mount Anderson area.

King County. - Quartz crystal is found in the Denny Creek, Bear Basin, Devil's Canyon areas and on the Clipper property.

Lewis County. - Agate occurs in Chehalis between Adna and Pe Ell, also on the Turner farm 4-1/2 miles east of Centralia. Peridot has been reported from the Doty area.

Idaho

Gem materials have been found in Latah, Valley, Cassia, Nez Perce, and Adams Counties, as follows:

| | |
|---|---|
| Latah County | - White opals |
| Valley County | - Topaz |
| Cassia County | - Topaz |
| Nez Perce County | - Garnet |
| Adams County | - Diamonds, sapphires and zircons |

Montana

Gem materials are found in Park, Granite, Powell, and Fergus Counties.

Park County. - Moss agate is found as pebbles along the Yellowstone River from Livingston to North Dakota. The agate from this area compares favorably with any found in the world.

Granite and Powell Counties. - The Perry-Schroeder Mining Co. of Helena has been dredging on Lake Helena to recover sapphires.

Fergus County. - The Yogo Gulch Mine, 50 miles southwest of Lewistown, has been closed for many years, but recently the Yogo Sapphire Mining Co. has been organized with the intention of reopening the workings. The gem stones produced are blue sapphires. Topaz and gem sapphires have been found also at the West Kendall mine on the west side of North Moccasin Mountain.

Reports of sapphire occurrences also come from the Rock Creek area and other areas of the western part of the State.

## Graphite

Graphite or plumbago, black lead, or kish, as it is sometimes called, is a soft, black, hexagonal form of carbon. It is usually found in foliated masses, disseminated flakes, or earthy lumps.



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Graphite may be separated into three classes: Natural, manufactured, and colloidal. Natural graphite is subdivided into crystalline and amorphous. Crystalline graphite includes flake, lump, chip, and dust. Amorphous graphite is a misnomer since all graphite is crystalline, however, the term is used commercially for grades in which the individual grains cannot be distinguished. Manufactured graphite is the pure crystalline form, and colloidal graphite is manufactured graphite subdivided until the individual particles approach the dimensions of solids in true solution.

The high melting point (3,000° C.) of graphite and its insolubility in acid create many uses for it. The oldest use is for making so-called "lead" pencils. The softest graphite is finely ground, mixed with clay, and baked; the amount of clay and time of baking govern the hardness. The chief uses of graphite, listed in the order of their importance, include - foundry facings, crucibles, lead pencils, lubricants, paints, dynamo brushes, electrodes, dry batteries, glazing powder, and stone polish.

Oregon

Graphite has been reported from Douglas, Harney, and Jackson Counties, however, little, if any, development has been done.

Douglas County. - A deposit of impure graphite is known 20 miles east of Roseburg.

Washington

Occurrences of graphite have been reported from Whatcom, Skagit, Snohomish, King, Chelan, Okanogan, Spokane, Lewis and Clark, Pierce, Yakima, Ferry, and Stevens Counties.

Okanogan County. - The American Graphite & Metals Corp. of Yakima is operating a flake-graphite deposit at Omak. A deposit east of Tonasket probably will be investigated in more detail.

Skagit County. - The Fairhaven Graphite Co., near Samish Lake, has a long record of production. Occurrences known as the Cultus Mountain and the Skagit River deposits have been reported.

Lewis and Clark County. - The Olympic Graphite Co. has reported past production.

Chelan County. - The Maverick Peak deposit, 6 miles east of Wenatchee Lake, as well as the Mason Creek and Wenatchee Lake deposits, may have commercial value.

Yakima County. - A deposit has been reported in the Naches River area west of Yakima.

Other deposits reported include:



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Ferry County - Renner Lake deposit
Stevens County - Near the town of Boundary
Spokane County - Sheep Mountain, east of Spokane.

Idaho

Occurrences of graphite have been reported from Lemhi, Camas, and Blaine Counties.

Blaine County. - Commercial deposits are known; but, since the prevailing price is so low, it is not feasible to mine any but the most favorably situated deposits. The known Idaho deposits, therefore, have not received much attention.

Montana

Graphite has been reported from Beaverhead and Madison Counties.

Beaverhead County. - Crystalline graphite of quality equal to that imported into the United States occurs in commercial quantities in the area southeast of Dillon. The Crystal Graphite mine in this area is operated by Montana Graphite, Inc., of Bozeman. The Graphite mine on the Birds Nest claim is less than 1 mile northeast of the Crystal Graphite mine. The Tri-State Minerals Co. has graphite associated with talc at the Timber Gulch talc mine 3 miles southwest of the Crystal Graphite mine. A graphite deposit 15 miles southwest of Armstead is in the prospect stage. Occurrences 12 miles west of Dell have been prospected but not proved.

## Gypsum

Gypsum is a hydrous calcium sulfate. It is one of the most-important industrial minerals and occurs in five varieties: Rock gypsum; gypsite, an impure earthy form; alabaster, fine-grained and translucent; satin spar, a fibrous form; and selenite, a transparent crystal form.

Its most important industrial property is that, after calcining, addition of water makes it into plaster of Paris and other quick-setting plasters. About 90 percent of the gypsum produced is used for building products - plaster, cement, and plaster board. It is used as a Portland-cement retarder and for fillers, paints, crayons, insecticides, and other minor uses.

Oregon

Gypsum has been reported from Wheeler, Crook, Grant, Union, Baker, Harney, Jackson, and Josephine Counties.

Baker County. - A deposit at Gypsum, on the divide between the Burnt and Snake Rivers, consists of clear, crystalline gypsum interlaced with chlorite. The Pacific Lime & Gypsum Co. operated in the area about 5 miles northeast of Huntington. The Acme Cement Plaster Co. of St. Louis, Mo., was the last operator.



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Crook County. - A deposit of unknown value is 30 miles east of Bend.

Grant County. - A deposit has been reported in the John Day area.

Jackson County. - A deposit has been reported at the Alton or Baron mine.

Josephine County. - Occurrences have been reported in the Galice district and at the Alameda mine.

Washington

Deposits of gypsum have been reported in Yakima, Chelan, Ferry, Okanogan, Pierce, Skamania, Stevens, Lincoln, and Spokane Counties.

Okanogan County. - Laucks Chemical Co. of Seattle is operating a deposit at Poison Lake. The company's product is marketed as Terra Green Gypsum. Deposits of gypsite have been reported at Lenton Flat and Bitter Lake.

The Columbia Gypsum Products Co. of Spokane is enlarging its Green-acres plant, 15 miles east of Spokane. Crude gypsum is obtained from its quarry at Windmere, B. C.

Idaho

Occurrences of gypsum have been reported from Custer, Butte, Clear Lake, Lemhi, and Washington Counties.

Washington County. - The Northwest Gypsum Co. has developed a deposit on the Snake River near Weiser.

Extensive high-grade deposits have been examined in Lemhi, Bear Lake, and Washington Counties. These deposits have not been developed because the low price of the crude product limits production to States near concentrations of population. Gypsum for building material usually is sold on an f.o.b. price plus freight from the nearest producing mill; therefore the plant location in relation to the market is a very important factor.

Montana

Gypsum occurrences have been reported from Meagher, Jefferson, Madison, Beaverhead, Cascade, Judith Basin, Ellis, Fergus, Park, and Carbon Counties.

Carbon County. - The first gypsum was mined in Montana by the Montana Plaster Paris Co. at its deposit 7 miles southeast of Bridger.

Fergus County. - The largest producers in the State are the United States Gypsum Co. plant at Heath and the Ideal Cement Co. gypsum and cement plant at Hanover. Deposits on the south flank of the South Moccasin Mountains and in the Big Snowy Mountains near Lewiston are commercial.

Other workable deposits are known in:



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Cascade County. - North flank of the Little Belt Mountains southeast of Great Falls.

Big Horn County. - West and east flanks of the Big Horn Mountains south of Billings, near Bridger and near Wyola.

Beaverhead County. - In the Mountains, 10 miles west of Lima.

Deer Lodge County. - Near Limespur, 40 miles east of Butte.

Meagher County. - A large deposit of gypsum recently has been reported 4 miles from Lingshire.

Most of these deposits are adjacent to or within reasonable hauling distance of railroads. Several of the deposits are of excellent grade and up to 10 feet thick.

## Limestone

Limestone and marble are used as a flux in smelting operations, in the manufacture of cement and lime, in sugar processing, in rock-wool manufacture, as agricultural limestone, in the chemical industry, in glass making; and as a dust for rock-dusting coal mines to render them less subject to explosions.

Some 25 million tons of limestone are utilized as a flux in metallurgical furnaces, particularly those of iron and nonferrous metals. It serves to offset silica and yield a thin slag and to produce a basic slag that collects the impurities separating from the metal. Metallurgical uses for lime are increasing. It is used for furnace fluxes, ore concentration, wire drawing, and in the foundry.

Pulverized limestone is used widely as a soil conditioner. The calcium in soils is water-soluble and is leached away, making the soils acidic. Agricultural limestone corrects this acidity and also granulates heavy clay soil, provides plant food, and promotes digestion of other fertilizers.

The use of limestone as a constituent of cement is treated under the Cement Materials section.

The principal markets for raw limestone in the Pacific Northwest are the 11 cement mills, 18 sulfite-pulp mills, and 2 lime plants and smelters.

The U. S. Lime Products Co. of Los Angeles, Calif., is considering building a 1.5-million dollar plant at Portland, Oreg. Much of the limestone will come from deposits on Kosciusko Island, Alaska.

### Oregon

Limestone is known in Baker, Clackamas, Coos, Crook, Curry, Douglas, Gilliam, Grant, Jackson, Jefferson, Josephine, Malheur, Polk, Wallowa, and Wheeler Counties.



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Baker County. - The most-important limestone deposit in eastern Oregon is that operated by the Oregon Portland Cement Co. at Lime, about 5 miles above Huntington on the lower part of the Burnt River (mentioned under Cement Materials section). The Chemical Lime Co. of Baker has diamond-drilled its property on Marble Creek and has indicated reserves in the order of 1,900,000 tons of metallurgical-grade limestone. A deposit on Conner Creek is being investigated. Good-quality crystalline limestone has been reported in the Sumpter area. Several small occurrences are known in the Table Mountain vicinity, 23 miles northwest of Baker. There also are deposits on Sisley Creek, 5 miles from Weatherby; at Nelson, 3 miles south of Durkee; in the Eagle Creek area on the southwest slope of the Wallowa Mountains; and between Washington and Dutch Gulches, 7 miles from Baker.

Clackamas County. - A deposit has been reported 1 mile northwest of Marquam.

Coos and Curry Counties. - Small deposits yield limestone for local markets.

Crook County. - Limestone occurs in the high portions of the Ochoco Mountains south of Canyon City.

Douglas County. - The Roseburg Lime Products Co. is producing a 90-percent $CaCO_3$ agricultural limestone from a deposit near Roseburg. The plant is serving farmers within a radius of 150 miles. Lander's quarry, a new deposit 10 miles east of Roseburg, is producing agricultural limestone. The Oden-Hatfield property is under investigation. A deposit known as the Byron limestone occurs in the Riddle area about 1-1/2 miles northeast of Ollala. The Hammersley deposit is in the same general area. The Oregon Portland Cement Co. abandoned a deposit near Umpqua in 1935.

Gilliam County. - A small, low-grade deposit near Arlington is suitable for local agricultural needs.

Grant County. - A small deposit suitable for local use occurs on Jackson Creek.

Jackson County. - The American Smelting & Refining Co. owns a deposit of white, crystalline limestone, which outcrops from the Seattle Bar on the Applegate River to beyond Manzanita Creek (a distance of more than a mile). Other deposits include: Briner and Ensele limestone near Jacksonville; and the Hughes, Beeman, and Bristol deposits near Gold Hill.

Jefferson County. - A siliceous marble occurs near the Grizzly post office (17 miles southeast of Madras).

Josephine County. - The Horsehead Lime Corp. of Medford has taken over the Washington Brick & Lime Co. property at Willamina. It produces burned lime. Limestone from Marble Mountain near Wilderville is being shipped by the Limestone Products Co. to Pacific Carbide & Alloys Co., Portland, Oreg. The Muck limestone property on Cheney Creek south of Wilderville is being explored, and a site for a mill is being investigated. The Jones limestone quarry is being developed. The Tirney or Calcium Products Co. deposit is in the lower



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Applegate area about 25 miles from Grants Pass. The Holton Creek limestone occurs in the Waldo area 3 miles south of Kerby.

Malheur County. - High-grade calcite (iceland spar) has been reported in veins in the vicinity of Dry Creek where it empties into the Owyhee Reservoir.

Polk County. - The Buell Lime Products Co., Salem, is producing agricultural limestone from its quarry at Buell. The Lime Products Co. is operating an agricultural limestone deposit at Dallas. The Polk County Lime Co., Salem, is quarrying agricultural limestone southwest of Dallas. Some of the output will go to rock-wool-manufacturing plants.

Wallowa County. - The Pacific Carbide & Alloys Co. of Portland is operating the Black Marble quarry at Enterprise. The limestone is shipped to Portland, where it is burned in the manufacture of calcium carbide. (See also under Stone section.) Deposits are known in the Snake River Canyon, Imnaha Canyon, and Wallowa Mountains areas.

Wheeler County. - Limestone occurs on Shoofly Creek between Mitchell and Redmond and in the area between Antone and Dayville.

Washington

Limestone deposits are known in Whatcom, San Juan, Skagit, Snohomish, King, Grays Harbor, Pacific, Lewis, Chelan, Okanogan, Ferry, Stevens, and Pend Oreille Counties.

Whatcom County. - The Mitchell Bay Lime Co. of Seattle is operating a deposit near Maple Falls. Not enough information is available for evaluating the following occurrences: Hilltop deposit, Sumas Mountain area near North Coal Creek, Black Mountain deposit, a deposit southeast of Baker Lake, and a deposit 2 miles below Ruby.

San Juan County. - The Everett Lime Co. of Tacoma is producing from the McCraw-Kittinger deposit on Orcas Island. The Roche Harbor Lime & Cement Co. is operating in the vicinity of Roche Harbor. Ray Van Moorhem is operating a quarry leased from the Roche Harbor Lime & Cement Co. in the West End area of the county. The Manufacturers Minerals Co. is operating on Cliff Island. The Wilson and Johnson deposits have recently been abandoned by the Mitchell Bay Lime Co. The following occurrences have been reported: Buck Mountain deposit on the northeast shore of Orcas Island; Langdon deposit on Orcas Island; Shaw Island; Krumdick; Rulo and Eureka deposits on San Juan Island; and the Henry Island deposits.

Skagit County. - The Roche Harbor Lime & Cement Co. is developing the Rockport deposit. The Jackman Creek and Sank deposits are undeveloped but considered commercial.

Snohomish County. - The Everett Lime Co. is operating the Granite Falls quarry. The Miller Lime Co. and the Consumers Lime Co. are operating near Gold Bar. Lime is being supplied to the Portland, Oreg., area by the Morcrop Lime Co. from its deposits near Arlington and Paddock. The Hidalgo Lime &



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Rock Co. and the Everett Lime & Cement Co. jointly own an unnamed deposit. The Everett Lime & Cement Co. also own the Galbraith deposit 6 miles west of Darrington, and the Canyon Creek Lodge deposit, which they operated formerly. The J. A. Jack deposit contains large tonnage suitable for the paper and sugar industries. Travertine is found at the Darrington deposit, at the Cutoff deposit 9 miles from Hartford, and at the Valley Gem deposit near Arlington. Occurrences known as the Twin Lakes, White Horse Mountain, and Marble Peak deposits have been reported.

King County. - The Guye Peak and Denny Mountain deposits have been reported.

Grays Harbor County. - The Humtulips deposit has been reported.

Chelan County. - The Alaska Marble Co. deposit is 10 miles north of Lake Wenatchee. Burned lime was produced formerly from raw materials from the South Shore and Deer Point deposits. Some production has come from the area 7 miles up creek from Entiat. Occurrences of large reserves of good-grade material are known along Lake Chelan and at Marble and Rainy Creeks. Occurrences known as the Wapato Lake, Martin Peak (northeast of Holden), and Buckskin Mountain deposits have been reported.

Okanogan County. - Limestone from the Lime Creek deposit was used to build the old Keller smelter. The following occurrences have been reported: Kruger Mountain, Golden, Wilkesville, Havilla, Orient, and the Riverside area.

Ferry County. - The Doblasue Lime & Mining Co. is operating the Doblasue deposit.

Stevens County. - Peter Janni & Sons is operating a deposit near Northpond. The Northwest Marble Products Co. is producing terrazzo chips in the Chewelah district. The United States Gypsum Co. is producing lime from a deposit near Evans. John Thompson of Colville is developing the Northport limestone along the Columbia River from Kettle Falls to Northport. Some of this material was used as a flux at the old Northport smelter. The Florentine Marble Co. is being supplied from a deposit at China Bend. The Keystone Marble Co. and the Jefferson Marble Mining & Milling Co. formerly operated in the area. The Chewelah Eagle Mining Co. is working the Chewelah Eagle Mining Co. is working the Chewelah deposit. The old Dominion limestone from Addy to Alladin was formerly worked. Travertine deposits at Burnt Valley (7 miles northeast of Chewelah), Black Canyon, and at the Last Chance Consolidated Mining Co. property probably will be examined in detail.

Pend Oreille County. - The Ione (Jordan) deposit supplied limestone to the Bunker Hill & Sullivan Co. for use as a flux. A deposit at Rogersburg is of commercial quality and quantity. Production has been reported from the Metaline Falls district.

Pacific County. - F. C. Green is working the Bear River deposit for agricultural uses.



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Idaho

Limestone is produced in Bannock, Butte, Boise, Clearwater, Teton, and Bonner Counties. Deposits, which have not been developed to a large extent, occur in Bear Lake and Blaine Counties.

Bonner County. - Limestone from this area is shipped to Spokane.

Butte and Teton Counties. - Limestone produced in these counties is shipped to various parts of Idaho and Utah for use in sugar refining.

Boise and Clearwater Counties. - The agriculture and poultry industries use most of the production from these counties.

The Bunker Hill & Sullivan Mining & Concentration Co., uses limestone from Jaques Spur as a flux.

Montana

Limestone is produced in Lewis and Clark, Carbon, Grant, Deer Lodge, Cascade, Park, Silver Bow, Beaverhead, Fergus, Sweet Grass, and Stillwater Counties.

Lewis and Clark County. - The most important source of quicklime and hydrated lime used in Montana is the Elliston Lime Co., 1 mile east of Elliston. The limestone is obtained from various local quarries. The area around Helena has produced burning lime and flux since the earliest days.

Carbon County. - Limestone for sugar refining is obtained from a quarry 4 miles northeast of Warren. Refineries at Billings, Hardin, and Sidney, Mont., and Sheridan, Warland, and Lovel, Wyo., are supplied.

Grant County. - Limestone mined in the Drummond area is used in sugar refining and as a metallurgical flux. Shipments are made to the American Crystal Sugar Co., Missoula; the Utah-Idaho Sugar Co., Chinook; and the Bunker Hill & Sullivan Mining Co., Kellogg, Idaho.

Deer Lodge County. - The concentrating plant and smelter of Anaconda Copper Mining Co., Anaconda, uses a continuous supply of lime and limestone from its quarry on Warm Springs Creek 7 miles west of the mill.

Cascade County. - Many tons of limestone have been produced from the area of Albright.

Gallatin County. - Production is reported at Trident.

Jefferson County. - A previously important producer at Limespur stopped operations recently.

Other areas that have past production records include:



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Park County - At Livingston
Silver Bow County - At Butte
Beaverhead County - Divide and vicinity

Fergus County. - A travertine deposit in the Lewiston area has been used as a local source of lime. Other deposits are known near Brooks and Hanover.

Stillwater, Sweet Grass, and Park Counties. - High-grade calcite occurs in a belt running through portions of these counties. Iceland spar (optical-grade calcite) was produced during World War II from the Wade property 4 miles southwest of Clyde Park, Park County. Calcite Operators, Inc., and its subsidiary, Crystal Cutters, Inc., supplied the Polaroid Corp. of Cambridge, Mass., with the raw material for ring-sight fabrication. A total of 5,340 pounds of acceptable-grade iceland spar was produced; for each pound of acceptable material 1,183 pounds was sorted.

Granite and Lincoln Counties. - Similar high-grade calcite has been reported from a deposit 7 miles east of Drummond (Granite County) and near Eureka (Lincoln County).

## Magnesian Minerals

Magnesite, dolomite, olivine, and serpentine will be considered under this heading. Magnesite is the mineral term for magnesium carbonate, but common use applies it to most of the manufactured products of the mineral. Dolomite is the mixed calcium-magnesium carbonate, olivine is a magnesian silicate, and serpentine is a hydrous magnesium silicate.

Magnesite is desired chiefly as a raw material for magnesium compounds and magnesium metal. Its nonmetallic uses call for calcination as the first step. The calcination is carried out at two different temperatures, depending upon application of the resulting oxide. At 1,200° C., it is burned to caustic magnesite, which is used for oxychloride or Sorel coments for stucco or flooring, as a chemical accelerator in rubber, as molded pipe coverings for insulation, and for some ceramic uses. Dead-burned magnesite has been heated to 1,450° C. and is a dense, weather-stable material used as a refractory or in refractory products. The dead-burned magnesite is a basic refractory and is used in contact with basic slags in metallurgical furnaces, for kilns, and for use with corrosive materials. Successful development of the basic converter, basic open-hearth, and electric furnaces is partly due to its use. Both crude and dead-burned dolomite is used as a refractory for basic open-hearth furnaces. Dolomite is used in place of magnesite whenever possible, because it is cheaper.

Olivine is a desirable refractory material to replace chromite in steel furnaces and to be used above the slag line in nonferrous furnaces. Olivine is mixed with magnesite to form low-cost fosterite brick. It has been used also as a fertilizer ingredient and as a raw material for preparing magnesium chloride and sulfate.

Serpentine when fibrous is listed under asbestos. The massive material is used as decorative stone, in refractories, as a base for paint, and as a



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diluent for insecticides. It has been used also experimentally as a source of epsom salts and magnesium metal.

Oregon

Magnesite occurrences have been reported in Josephine County, near Holland, and in the Illinois River, Smith River, and Diamond Creek areas of Coos County.

An acceptable grade of dolomite is known to occur in the Wallowa Mountains in the Union-Umatilla County area.

Millions of tons of serpentine are known in Grant, Baker, Jackson, and Josephine Counties.

Washington

Magnesite has been reported from Skagit, Snohomish, Kittitas, Chelan, Okanogan, Ferry, and Stevens Counties. The largest magnesite production in the United States comes from Stevens County, Wash.

Stevens County. - The Northwest Magnesite Co., Pittsburgh, Pa. (jointly owned by the General Refractory Co., Inc., and the Harbison-Walker Refractory Co.), is mining magnesite at the Finch, Red Marble, and Keystone quarries. It also has the Allen and Moss quarries. The calcining plant is near Chewelah. This is the largest magnesite operation in the United States. The Woodbury deposit was operated during World War II. The Crosby deposit, Double Eagle quarry, U. S. Magnesite quarry, and the Turk deposit are commercial but, as yet nonproducing properties.

The nickel ledge or silicate-carbonate rock found in Snohomish, Skagit, Chelan, and Kittitas Counties consists of magnesite in a chalcedony and quartz matrix. Small amounts of nickel, chrome, and gold are present also. The deposits include:

| | |
|---|---|
| Skagit County | - Swinomish Bay and Mount Vernon |
| Snohomish County | - Granite Falls |
| Kittitas County | - Boulder Creek |
| Chelan County | - Blewett and Ingals Creek |

Dolomite occurs in Stevens, Ferry, Okanogan, and Lincoln Counties.

Stevens County. - The Manufacturers Mineral Co. (Mineral Products Co.) of Seattle is operating the Valley quarry. Other deposits in the county having possible commercial value are near Chewelah, Colville, and Addy.

Chelan County. - The Keegan Mining Co. of Wenatchee is producing dolomite, fire clay, brick clay, and silica sand at Entiat, Riverside, and Wenatchee.

Okanogan County. - The dolomite deposits of the Riverside district are in the Columbia and Okanogan Valleys. N. W. L. Brown of Wenatchee is operating the Riverside quarry.



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Lincoln County. - Dolomite is reported from the Old Fort area at the northern border of the county, about 45 miles west-northwest of Spokane.

Ferry County. - The deposits show little change of development because they are small and discontinuous.

The magnesite and dolomite of Stevens County could be used for molded insulation.

Olivine has been reported from Whatcom, Skagit, Lewis, Kittitas, and Okanogan Counties.

Skagit County. - Manganese Products, Inc., of Seattle is operating the Olivine Hill deposit, on Cypress Island. The olivine is fused with phosphate rock to make fertilizer. The Reef Point and Strawberry Bay deposits may be worked by the same company. H. P. Schell, Seattle, has shipped refractory-grade olivine east from his Big Slide mine near Sedro Wooley.

Whatcom County. - A "mountain of olivine ore" occurs near Bellingham. The geographic location has prevented anything but preliminary development to date. The Twin Sisters Mountain deposit has potential value as a source of refractory material. An occurrence known as the Sumas Mountain deposit has been reported.

Massive serpentine has been reported from Whatcom, San Juan, Skagit, Snohomish, and Chelan Counties.

San Juan County. - Large potential sources of serpentine are known on Cypress Island and at Fidalgo Head. Burrows Island, Allan Island, and Hat Island are composed of serpentinized dunite.

Skagit County. - Dot Island and Saddlebag Island consist almost entirely of dunite. The Burlington deposit, a hill of serpentinized greenstone, probably will be examined further. The Oso deposit is very large and could be mined easily.

Snohomish County. - A large area near Darrington probably has commercial possibilities. A deposit at Granite Falls contains dark-green to black serpentine associated with talc. The Sultan Basin deposit, a serpentinized peridotite, has been reported.

Chelan County. - A serpentinized peridotite in the Wenatchee Mountain area is a potential producer.

Idaho

An occurrence of magnesite has been reported in Caribou County. No dolomite, olivine, or serpentine information was found.

Montana

No commercial deposits of magnesite are known. Springs high in magnesian salts are found near Conrad in Pondera County.



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Three deposits of impure dolomite have been reported in Lewis and Clark and Big Horn Counties.

No olivine or serpentine references were found.

## Mica

Mica is the term applied to a group of silicates, consisting principally of potassium, aluminum, and magnesium. Muscovite, phlogopite, lepidolite, and biotite are used commercially. Lepidolite and zinnwaldite and roscoelite are the sources of lithium and vanadium, respectively.

An important property of mica is its perfect basal cleavage, which permits it to be split into thin sheets or films. Muscovite and phlogopite can be split into sheets 0.0001 inch thick or less; biotite does not split as well. The cleavage, combined with low heat conductivity, high dielectric strength, flexibility, resilience, and toughness, make the light-colored micas outstanding electrical insulators. Muscovite withstands temperatures as high as 550° C. and phlogopite, up to 1,000° C.

Most of the sheet mica produced is for electrical insulation, chiefly in condensers, tubes, radio, radar, and television. Large sheets go into electrical heating elements. Films are bonded with shellac into plates and cut to desired shapes. Airplane spark plugs are built of bonded phlogopite.

Wet-ground mica gives luster to wall paper and some paints; it is used also as a filler in rubber and some plastics. Dry-ground mica is used for roofing materials, stucco, rubber-dusting powders, and molded electric insulation.

Since the beginning of the electrical age, use of mica in electrical equipment and appliances has developed to such an extent that the known sources of supply are scarcely equal to the demand.

### Oregon

Mica occurrences have been reported in Douglas and Jackson Counties, but they have not been developed.

### Washington

Mica occurrences have been reported in Snohomish, Chelan, Stevens, Spokane, Skagit, King, Okanogan, and Pend Oreille Counties.

Chelan County. - A lepidolite deposit on the property of the Royal Development Co. is under development. Other deposits that have been reported include:

Chelan Falls deposit - Phlogopite sheet.
Gowan deposit in Winesap Canyon - Muscovite sheet.
Mad River deposit north of Leavenworth.
Tumwater deposit 5 miles northwest of Leavenworth -
Large mass of muscovite schist that is easily disintegrated.



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Skagit County. - The Skagit Talc Co. has a schist suitable for a roofing material. The Alvard deposit probably will be studied in more detail.

Snohomish County. - The Barclay Creek deposit may be a source of sheet mica. Some sheets of muscovite measuring more than 8 inches across have been found.

Ferry County. - A mica occurrence known as the Sherman Creek deposit has been reported.

Spokane County. - A mica deposit has been reported near Dennison. A suitable product probably can be made by washing the fine mica flakes from a kaolin clay in the Freeman mica area.

Idaho

Deposits of mica are known in Latah, Idaho, Lewis, Adams, Washington, Boise, Shoshone, and Cassia Counties.

Latah County. - The Mica Processing & Mining Co. of Weiser is developing a mica-beryl pegmatite deposit in the vicinity of Avon. The DeAnza Engineering Co., San Francisco, Calif., will produce ground mica from scrap at the Muscovite pegmatite mine's Avon property.

The commercial-grade deposits in Latah, Idaho, and Adams Counties have not been developed in proportion to their possibilities.

Montana

Mica has been reported from Lincoln, Ravalli, Cascade, and Madison Counties.

No extensive deposits of mica are known in the State.

Madison County. - About 10 tons was marketed from the Sappington deposit. A small amount was produced from the Dulea and Montana deposits near Virginia City.

The large granitic and pegmatitic areas of the southwestern part of the State may yield commercial deposits if prospected.

## Mineral Wool

Mineral wool is an artificial product composed of extremely fine fibers of silicate glass. It is widely used for insulation and owes its insulating properties to innumerable minute air pockets, which are entrapped by the fibers of wool and prevent the transfer of heat by convection and likewise trap and dissipate sound waves. The term "mineral wool" has been used to include rock wool, slag wool, glass wool, glass silk, and silicate cotton. There seems to be a tendency to include only slag and rock wool and consider the others under another category. The term "rock wool" originally was applied only to mineral wool made from natural rock; it is now includes that made from slag also.



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The production of all types of mineral wool is similar in that the molten mass is subjected to a blast of steam or compressed air or a tensile and/or shearing force that draws it out into fibers. In making rock or slag wool, the pieces of the batch are melted in water-jacketed cupolas. One plant uses an electric-induction furnace.

The major constituents of commercial mineral wool are silica, lime, alumina, and magnesium. Rock wool is made from natural woolrocks and composite woolrocks. These are usually impure carbonate high in silica or silt, cherty carbonates, calcareous sandstone or shale, some glacial clays and gravels. High iron, sulfur, and calcium sulfide are objectionable.

Slag wool usually is made from iron-blast furnace slag, but copper and lead slags are used also.

The main uses are for home insulation. Minor uses include insulating pipes, stoves, refrigerators, boilers, and air-conditioned trains and sound insulation.

Shipments of mineral wool in the Pacific Northwest seem confined to Washington. If a suitable market were available, the slags from smelters in Idaho and Montana would provide a source of the raw material.

Washington

Cowlitz County. - The Canney-Pacific Co. of Mankato, Minn., has a $250,000 plant at Longview. The company has two cupolas with an annual capacity of 20,000 tons of rock wool. A lime-silica rock from the vicinity of Dallas, Oreg., and blast-furnace slag from the Fontana mill in Utah provide the raw materials.

Pierce County. - The Feltrok Insulation Manufacturing Co. has a plant at Tacoma.

The siliceous limestone of the Olympic Peninsula probably would serve as a raw material for mineral-wool manufacture.

## Peat

Peat is an accumulation of partly decomposed vegetable matter that represents the first stage in coal formation. Peat is not coal, although it is used as a fuel.

For many years peat has been used in this country for soil improvement. Of the total production, approximately 59 percent is used for soil improvement, 32 percent for mixed fertilizers, and 9 percent for other purposes, including litter for poultry yards, turf conditioner for golf greens, and as bedding in greenhouses and landscape planting.

Some European countries use peat for fuel and power, but ample supplies of higher-grade fuels in this country eliminate peat as a fuel. However, a



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bill has been introduced in the Senate that, if enacted, will authorize the United States Department of the Interior survey the possibility of using peat and its related byproducts to increase our energy supply, thereby aiding in the conservation of our fuel resources.

Washington is the principal producer in the Pacific Northwest.

Oregon

Peat deposits are known in Baker, Coos, Deschutes, Harney, Klamath, Lane, Marion, and Washington Counties.

Washington

The number of peat operators in the state are too numerous to list in detail. Twenty-six listings were found - 12 in King County, 7 in Snohomish County, 2 in Kitsap County, and 1 each in Spokane, Pierce, Clark, Mason, and Thurston Counties.

## Phosphate Rock

Apatite, the calcium chlorofluorophosphate, is the primary phosphate mineral from which all other phosphates are derived. Most of the world production of phosphate for chemicals and fertilizers comes from these secondary apatites, called phosphorites. These calcium, magnesium, iron, and aluminum phosphates have been formed by the alteration of sediments by solutions containing phosphoric acid. Both apatite and the phosphorites are known to the trade as phosphate rock.

Plant life cannot survive without phosphate. Before the time of man the phosphate in all vegetation traveled in a cycle - it went from the soil into the plants, and when the plants or its parts decayed and died, the phosphate returned to the soil. Where the soil was deficient in phosphate, little vegetation grew. Man has learned to replenish the phosphate taken by plants from the soil.

In normal times about 90 percent of the phosphate rock mined is consumed by the manufacturers of superphosphate and other phosphate fertilizers. The remainder is used for making elemental phosphorus, from which phosphate chemicals are made. During wartime, elemental phosphorus is used in incendiary bombs.

Superphosphate and triple superphosphate are made by acidulating finely ground phosphate rock with sulphuric acid. Most of the phosphate in triple superphosphate is converted to orthophosphoric acid, which in turn is used to acidulate more phosphate rock. This results in the conversion of almost all the tricalcium phosphate to monocalcium phosphate.

A New Zealand chemist produced a superior fertilizer, at lower cost, by mixing commercial superphosphate with serpentine.

No phosphate-rock deposits have been reported in Oregon or Washington.



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Idaho

Phosphate-rock deposits in Bear Lake, Caribou, Bannock, Bingham, and Bonneville Counties have been estimated to contain as high as 35 percent of the total United States phosphate reserves.

Bear Lake County. - Phosphate rock from Montpelier and Paris will be used by Gates Bros. new plant at Wendell to produce superphosphate. The San Francisco Chemical Co., of San Francisco, Calif., did not operate its Waterloo mine near Montpelier during 1948. The McIlwee Idaho Phosphate Co., San Diego, Calif., is not operating its property at present. The Teton Phosphate Co. of Montpelier is operating in the county.

Bingham County. - The Simplot Fertilizer Co. of Pocatello is operating the Gaymine on the Fort Hall Indian Reservation. The company has obtained a Government lease on a strip in Caribou County. The phosphate rock will be processed at the Salt Lake City, Utah, plant. The Union Pacific Railroad has recently completed a 23-mile spur to connect the Simplot Co. phosphate-rock pits with the superphosphate plant and with the new $4,000,000 Westvaco Chemical Corp. plant at Pocatello.

Bannock County. - The Westvaco Chemical Division, Food Machinery & Chemical Corp. has erected the first electric furnace in the Pacific Northwest for producing elemental phosphorus at Pocatello.

Caribou County. - The Anaconda Copper Mining Co. is operating its mine 3 at Conda.

Montana

Enormous reserves of phosphate rock occur in the lower part of the Phosphoria formation. It is being mined in Powell, Granite, Beaverhead, Madison, and Silver Bow Counties.

Powell County. - The Montana Phosphate Products Co., with offices in Garrison, Mont., and Trail, B. C., is the largest producer. All of the production from the Anderson, Gravelly, and Duke mines is exported to Trail. George Relyea of Garrison ships his production to Trail. The Silica Products Co., Inc., of Tacoma, Wash., did not operate its mine at Elliston during 1949.

Granite County. - The Manganese Products Co. of Seattle, Wash. shipped from its Edgar mine at Hall in the Philipsburg district. The International Minerals & Chemical Corp. of Chicago, Ill., is developing the Douglas Mountain mine. Soluble Phosphates, Ltd., is operating a mine at Maxville.

Deer Lodge County. - The Anaconda Copper Mining Co. at Anaconda is expanding its plant facilities to produce more phosphoric acid and superphosphate.

Silver Bow County. - The Victor Chemical Works of Chicago, Ill., is operating a plant at Silver Bow. The Anderson Phosphate Mines, Inc., of Butte is developing the Melrose mine.



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## Quartz Crystal

Quartz (silicon dioxide) is a common rock-forming mineral. However, when it occurs in well-defined crystals free of imperfections, it is a strategic industrial mineral. The major use for quartz crystal, because of its piezoelectric properties, is in the manufacture of radio oscillator plates and telephone resonator and filter crystals. It is used also as a semiprecious gem stone. Optical parts for special purpose instruments are made also from quartz crystals. Chips and small crystals (less than 100 grams) are called lascas and are the raw material for fused-quartz products.

The piezoelectric (electric polarity due to pressure) properties of quartz crystal were a laboratory curiosity before World War I. At that time, a supersonic device for the detection of submarines, using quartz plates, was developed for the French Navy. World War II saw marked improvements in communication equipment, and the need for quartz crystal made it a strategic material of of prime importance.

The most-significant development in the quartz-crystal industry during 1949 was the favorable progress in the synthesis of quartz crystals and other piezoelectric crystals and improvement in utilization of available natural crystals.

The only known occurrence of quartz crystal in the Pacific Northwest suitable for electrical application is the Be Van quartz-crystal deposit in Lemhi County, Idaho.

## Refractories

Modern high-temperature metallurgical processes require refractory materials for furnace linings that will withstand high temperatures; if the material shows signs of fusion below 1,500° C. it is not classed as refractory. Other requirements are that refractories should not react with the materials being melted; they must be strong enough to withstand the weight and wear of molten metal and slag, they must resist cracking and spalling under temperature changes, and they must have properties that will enable them to be molded to any desired shape. Some refractories are used for high-temperature purposes other than furnace linings, such as retorts, electrical applications, and ceramics.

The iron and steel industry uses about half of the refractories made for its blast furnaces, steel furnaces, open hearths, and related equipment. Public utilities use them for electrical power and gas plants, locomotives, incinerators, and other purposes. Refractory linings are needed for smelting and refining metals, in cement and other type kilns, making spark plugs, and many other high-temperature purposes.

The common refractories may be classified under the following group headings: Fire clay, silica, high-alumina, magnesite, and chrome.



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Fire clay. - Any clay that has a pyrometric cone equivalent of 19 (1,515°C.) or higher. This type of clay is used in the manufacture of fire brick and other refractories.

Silica refractories. - The most common forms are quartzite (ganister) and crushed quartz, which, when bonded with 2 percent lime, yield silica brick, an important acid-refractory product utilized in many metallurgical processes.

High-alumina refractories. - The sillimanite group of minerals (sillimanite, kyanite, andalusite, and dumortierite) all convert upon heating to mullite (melting point, 1,810° C.). Mullite is a high-cost but much-desired refractory, especially for tough porcelain bodies used for spark-plug cores, electrical and laboratory porcelains, and saggers. Bauxite with a clay binder is fired to a high-alumina refractory brick used chiefly for lining open-hearth steel furnaces. High-alumina refractory bricks also are made from diaspore and combinations of plastic clays.

Magnesia refractories. - Dead-burned magnesite is used as a basic refractory for basic slags in metallurgical furnaces, for kilns, and for use with corrosive materials. Dolomite is preferred because it is cheaper. Spinel is made artificially by fusing calcined magnesite and alumina in an electric furnace.

Only occurrences of the sillimanite group of minerals (high-alumina refractories) will be considered in this section, because the other materials have been covered in preceding sections.

Investigations using domestic sillimanite for making high refractories are being conducted by the Bureau of Mines Electrotechnical Laboratory, Norris, Tenn.

Oregon

There have been no reports of occurrences of the sillimanite group of minerals in Oregon.

Washington

The sillimanite group of minerals has been reported from Spokane, Skamania, San Juan, Skagit, Chelan, Kittitas, Stevens, and Pend Oreille Counties.

Stevens County. - Not enough information is available for evaluating the Onion Creek deposit.

Idaho

Occurrences of the sillimanite group of minerals have been reported in Shoshone, Latah, Blaine, and Cassia Counties.

Latah County. - There is an extensive deposit of a sillimanite-bearing rock near Troy. It is amenable to beneficiation by flotation, as determined by investigations of the Troy Sillimanite Co.



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Montana

The sillimanite group of minerals occurs in Madison, Gallatin, Beaverhead, Park, and Granite Counties.

Madison County. - The principal deposits of the sillimanite group of minerals are found 13 miles southwest of Ennis. They occur as irregular and pockety concentrations in pegmatite and gneiss. It is difficult to estimate the actual tonnage; large areas are known to average 1 to 8 percent, with local concentration as high as 50 to 60 percent. A small, high-grade sillimanite deposit (50 to 65 percent) occurs on Bear Trap Creek 10 miles southeast of Norris. Deposits of kyanite are known also in the Norwegian Gulch area.

Gallatin County. - There is a deposit 12 miles southwest of Bozeman, ranging from low to high grade, associated with corundum. The Gallatin deposit (also called Montana or Fuller deposit) 17 miles southwest of Bozeman is variable in grade and was worked for corundum during World War II. The Bozeman deposit is 12 miles southwest of Bozeman.

Beaverhead County. - Sillimanite occurs in a garnet-sillimanite gneiss 23 miles southeast of Dillon (Timber Gulch). Several sillimanite deposits are 9.5 miles southeast of Dillon on Carter Creek. Sillimanite occurs also in a biotite-garnet schist on the property of the Crystal graphite mine 10 miles southeast of Dillon.

Park County. - There is an andalusite-bearing pegmatite and a sillimanite-andalusite aplite in the Jardine district adjoining Yellowstone Park.

Granite County. - An andalusite-mica schist and a sillimanite-mica schist have been reported in the Philipsburg area.

Lewis and Clark County. - Kyanite has been reported from the Missouri River bars, 16 miles from Helena. The Eldorado, Ruby, and other bars have yielded kyanite and topaz.

## Sand and Gravel

(Including special sands)

Sand and gravel are unconsolidated granular materials resulting from the natural disintegration of rocks. The two materials usually occur together, variably proportioned and widely distributed. Commercial sand comprises the fine, granular material, usually less than 1/4-inch, and gravel the 1/4- to 3-1/2-inch-diameter fraction.

Special sands invariably are high in silica and consist chiefly of quartz grains. Their particular uses, in some cases, demand careful grading: Iron oxide is removed from a glass sand and a certain amount of clay is desirable in a foundry sand. The uses of special sands include: Foundry purposes, glass manufacture, filter beds, abrasive purposes, sand blasting, engine sand, sand for sheet asphalt, and furnace sand. Most of these special sands are



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obtained from deposits of unconsolidated materials; some high-silica sands are obtained from soft sandstones that disintegrate easily. Quartzite has been used.

Foundry sands. - Siliceous sands that are used to make forms for casting metals. If used for making molds, they are known as molding sands, and if used for the cores that form the hollow spaces in the castings, they are called core sands. The naturally bonded sands contain enough clay to act as a bond. Synthetic sands, now used extensively, are a mixture of sand with fire clay or bentonite. Core sands may be bonded with oil, pitch, resin, or other materials. The term "sharp sand," as used by foundrymen, refers to sand free of any bonding material.

Glass sand. - The grade can vary with the type of glass made. It may range from high-silica with very low iron to lower-silica and up to 1 percent iron oxide. All grains must pass a 20-mesh screen, and very little should be finer than 100-mesh.

Glass making in the Pacific Northwest is confined to container glass. Some sodium silicate (water glass) is made.

Filter sand. - Many municipalities remove sediment, suspended matter, and bacteria from water by filtering through sand. This use calls for a high-silica sand of fairly uniform grain size.

Furnace sand. - This type of sand is high in silica and contains a bonding material. It is used for lining the sides and bottoms of open-hearth steel furnaces.

The sand and gravel industry ranks very high in the industrial mineral economy of the Pacific Northwest. The number of operations is too numerous to mention in detail. Only the sources, proved or potential, of the special sands will be listed by States.

Oregon

Silica and silica-sand deposits are known in Baker, Douglas, Grant, Harney, Jackson, Josephine, Lane, Umatilla, and Wheeler Counties.

Baker County. - Silica is being recovered as a byproduct from a gold-silver operation in the Bald Mountain mine near Sumpter. Extensive deposits of vein quartz occur in the county.

Grant County. - Deposits of vein quartz are distributed throughout the county.

Harney County. - Vein quartz and large masses of quartz are found in the Pueblo Mountains near the Nevada line. Silica sand can be found in dunes separating Lakes Harney and Malheur.

Jackson County. - The Rhyno silica deposit is 3 miles northwest of Wimer.



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Josephine County. - The Bristol Silica Co. is producing quartz from the Rogue River area to supply its crushing plant at the town of Rouge River. The crushed quartz is used for poultry grit and for metallurgical and other specialized uses. The Harbison-Walker Co., a large refractories concern, has entered into an arrangement with the Bristol Silica Co. for joint operation of the silica quarry. The quarried quartz is to be shipped to San Francisco to be used in manufacturing silica brick. The Snyder-Mackie silica deposit is 3 miles from Hugo. The product from this operation formerly was shipped to Columbia Steel and Electric Steel in Portland, Oreg. A deposit of orbicular silica, called oregonite, is found on the Riverside claim in the Illinois River area.

Lane County. - The Silica Products, Oregon, Ltd., has produced a foundry sand from the Eugene area. This was sent to the Portland market. Three deposits occur in the area between 2-1/2 and 17-1/2 miles east of Eugene.

Umatilla County. - Vast sand dunes occur along the south bank of the Columbia River between Riggs and The Dalles.

Washington

Deposits of special sands have been reported in Whatcom, Skagit, Chelan, Kittitas, Pierce, Thurston, Grant, Ferry, Stevens, Spokane, Whitman, Mason, Grays Harbor, Pacific, King, Lewis, Clark, Klickitat, Okanogan, and Douglas Counties.

Skagit County. - Skagit Mineral Products Co. (Northwest Crushing Co.) of Seattle has a high-grade silica deposit 2 miles west of Merritt. It formerly produced pulpstone and crushed quartz that was shipped to the Tacoma smelter and Northwest Glass Co., Seattle, for use as molding and glass sand, respectively. The Eversharp Pulp-Burr Co. of Tacoma operates a deposit near Rockport. R. J. Hendric of Portland, Oreg., is developing the Stoner property. The Doris deposit probably will be examined in detail.

Spokane County. - The Pacific Silica Co. of Seattle is producing silica from the Latshaw (Dennison or Silica Hill) deposit. The Crystal Line Products Co. of Spokane is operating the Mead (Berk) deposit. The McKinley deposit may yield a product suitable for a molding or furnace sand. Sand suitable for potters' flint or glass sand possibly can be recovered from deposits in the area of Mica and Freeman by washing out the clay.

King County. - The Hammer Bluff deposit is being operated by the Smith Bros. Silica Sand Co. M. B. Cavanaugh MoldingSand Co. of Kennydale is operating in the Cedar Mountain area. A deposit at White River was operated formerly by the Denny-Renton Clay and Coal Co. Gladding, McBean & Co. has a deposit southwest of Issaquak that has potential value as a molding sand. Alcorn Bros. is producing a molding sand. Other occurrences that can produce a product suitable for molding sand include: G. H. Wilde deposit, Otter Lake deposit, and the Brooke deposit.

Stevens County. - The Manufacturers Mineral Co. (Mineral Products Co.) of Seattle is producing silica and molding and blast sand from its Chewelah pit.



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Norman Hill of Olympia is developing the Marshall (Lyons Hill) deposit, 9 miles southwest of Springdale, for possible use as glass, molding, and white plaster sand. The Lane Mountain deposit has potential value. Occurrences known as the Steinmetz, Steep Cliff, and Inklers Point deposits have been reported.

Pacific County. - The Nemah River and Fender deposits have been reported.

Grays Harbor County. - The Montesana deposit has produced several carloads of molding sand. The East and West Aberdeen deposits have potential value as foundry and molding sand, respectively.

Pierce County. - The Steilacoom deposit is being operated by the Pioneer Sand & Gravel Co. to produce engine and blasting sand.

Chelan County. - N. W. L. Brown of Wenatchee is operating the Squillchuck quarry. The Merritt quarry formerly furnished crushed quartz to the Ohio Ferro-Alloys Co. for manufacture of ferrosilicon. The Burch Mountain deposit has been reported. The Stemlit Canyon deposit consists of a high-silica sandstone that could be crushed to yield pure quartz.

Clark County. - The Wilde Co. of Vancouver is producing a molding sand from its deposit in the Salmon Creek area.

Pend Oreille County. - The Scotia quarry is operated by the Great Northern Railroad Co.

Spokane County. - The Moran Prairie deposit probably will prove valuable because of its proximity to Spokane.

Whitman County. - The following deposits have been reported: Stratton Butte, Steptoe Butte, Ladow Butte, Ringo Hills, and Kamiah Butte.

Cowlitz County. - The Owens Illinois Glass Co. plans to build a container-glass plant at Longview.

Pierce County. - The Philadelphia Quartz Co. of Tacoma uses sand from a deposit near Spokane to make sodium silicate.

King County. - The Northwestern Glass Co. of Seattle uses ground quartz in its operation.

Idaho

Special sands have been reported from Bonner, Kootenai, Boncwah, Latah, Boise, Gem, Lemhi, Cassia, Caribou, and Bear Lake Counties.

Gem County. - J. R. Dewey (Gem Silica Co.) of Emmett is producing a high-grade foundry sand.

Montana

Deposits of special sands have been reported from Fergus, Deer Lodge, and Beaverhead Counties.



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Beaverhead County. - A glass sand assaying 98 percent silica is located at Daly's Spur south of Dillon. The very fine size seems to be objectionable to consumers.

Fergus County. - A silica-sand deposit, 3 miles southwest of Hilger, is suitable for molding and foundry uses or in the manufacture of green or amber glass.

## Stone

For the purposes of this report, dimension stone and crushed stone will be included under the heading Stone.

Dimension stone is the term applied to stone used as blocks or slabs of specified sizes and shapes, including cut stone, building stone, ashlar, paving blocks, curbing, and flagging. Granite, sandstone, limestone, and marble are the principal varieties. These rocks must have a uniform texture and grain size, constant and attractive color, and freedom from impurities that may cause stain or deterioration.

Any of the three rock groups - igneous, sedimentary or metamorphic - can be the source of crushed stone. The terms "trap rock" and "granite" as used in the crushed-stone industry indicate color and texture rather than mineralogy. The dense, dark, fine-grained rocks, such as basalt, diabase, and andesite, are classified as trap rock, and the coarser-grained and light-colored granites and syenites are classified as granite. Both trap rock and granite are igneous rocks. The largest tonnage of crushed stone comes from the sedimentary group represented by limestone and sandstone. Quartzite and marble are the most important of the metamorphic group.

Crushed stone finds many uses, among which are: Riprap, aggregate in highway construction (road metal), concrete, railroad ballast, and in the filter beds of sewage-disposal plants.

Certain volcanic rocks - pumice, perlite, and tuff - are finding increasing use, mainly in the category of crushed stone but also as dimension stone. Most of the pumice is used as aggregate in precast building blocks, although some is used in monolithic pours and for loose fill insulation. Granular pumice is used for chicken-coop litter and by florists as a bedding material. The newest industrial application of pumice is its use as a plaster aggregate, which is lighter than sand and stronger than perlite. Uses of perlite include: Plaster aggregate, loose fill, insulation, and florists' bedding material.

The Pacific Stoneware Co., Portland, Oreg., has used perlite experimentally as a feldspar substitute in a ceramic glaze for stoneware jars. The iron content imparts a faint yellow tint. An advantage would be the need for only one firing as compared with two firings when feldspar is used.

The use of volcanic ash- (pumicite-) coated seeds has been reported recently. Even the smallest seeds are made large enough to handle separately after being coated. Fertilizers and fungicides can be added, thereby virtually insuring germination and growth.



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Oregon

(a) Dimension Stone.

There are deposits of granite in Baker, Jackson, Josephine, Union, and Wallowa Counties.

Baker County. - The Northwestern Granite Quarry at Haines is producing ornamental granite.

Jackson County. - The Ashland Granite Quarry (formerly Blair Granite Quarry) on Neil Creek, 8 miles south of Ashland, produced ornamental stone that is said to compare with the famous Barre (Vt.) granite. The Oregon Granite Co. has operated a quarry 2 miles north of Jacksonville. The Gold Ray Granite Co. formerly operated about 2 miles west of Tolo on the Southern Pacific Railroad.

Josephine County. - A granite deposit has been reported in the Grants Pass area.

Union County. - Deposits have been reported in the vicinity of Elgin and La Grande.

Sandstone deposits are known in Benton, Columbia, Coos, Curry, Douglas, Harney, Jackson, Lincoln, Malheur, Marion, Tillamook, and Washington Counties.

Benton County. - Sandstone for local use has been quarried in the area around Corvallis, Monroe, and further south.

Columbia County. - A deposit has been reported from the vicinity of Marshland.

Coos and Curry Counties. - Sandstone is abundant in the Coast Range and along the Umpqua, Coos, and Coquille Rivers. Sandstone quarried near Port Orford has been shipped to San Francisco.

Douglas County. - Past production has been reported from the Oakland area.

Harney County. - Sandstone occurs in the Silver Lake area.

Jackson County. - The Tyee sandstone has been quarried at Eagle Point, Gold Hill, and Medford.

Lincoln County. - The principal quarry of western Oregon is at Pioneer on the Yaquina River. The product formerly was shipped to San Francisco.

Malheur County. - Sandstone occurs near Vale and at The Narrows.

Marion County. - A deposit 2 miles from Jefferson has yielded monumental stone. Oregon's contribution to the Washington Monument came from this deposit.



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Tillamook County. - Past production has been recorded from a quarry 6 miles north of Bay City.

Washington County. - Sandstone from Boose's quarry, 5 miles south of Forest Grove, formerly was used as a building stone.

A deposit of limestone, operated by the Black Marble & Lime Co. of Enterprise, Wallowa County, furnishes a handsome, jet-black stone when cut and polished.

Deposits of volcanic rock, used for building purposes, are known in Baker, Crook, Deschutes, and Marion Counties.

Baker County. - The Loye Corp. of Portland is experimenting with blocks sawed from tuffs in the Baker Area.

Crook County. - A pinkish-white rhyolite tuff found near Crooked River is being used as a building stone. It has the necessary physical properties in addition to its interesting and attractive appearance.

Deschutes County. - A volcanic tuff in seven colors is being processed by the Perma Building Stone Co. of Bend, Oreg. The recently installed rock sawmill produces decorative stone for fireplaces, inlays, and patios, as well as ornamental stone for building facings.

Marion County. - The Tuff Stone Co. of Portland is producing sawed blocks of volcanic tuff (Fern Ridge tuff) from a quarry 6 miles southeast of Sublimity. The Mount Angel quarry, near the head of the Little Abiqua Creek, produced building stone from the Fern Ridge tuff. Local buildings and a church in Portland were made from the material. The Silver Creek quarry, between Silver Creek and Drift Creek southeast of Silverton, produced from an outcrop of the same rock series. The stone was used in construction at the Silver Creek Falls Park.

(b) Crushed stone.

Most of the crushed stone produced in Oregon comes under the classification of volcanic rocks - pumice and perlite.

Occurrences are known in Wasco, Clackamas, Umatilla, Deschutes, Douglas, Jackson, Lake, Harney, Klamath, Baker, and Malheur Counties.

Deschutes County. - The Central Oregon Pumice Co. of Baker is producing aggregate of various sizes. The Deschutes Concrete Products Co. is producing pumice at Redmond. Lloyd A. Williamson of Bend has crushing plants at Bend and Tumalo. The Pumice Engineering Co. of Bend is producing block aggregate and pumice plaster at its mill. Grimes Pumice Block Co. of Bend is producing building block. The Cascade Pumice Co. and the Volcanic Materials Co. are producing in the same area. The B & B Mortarless Block Co. of Pendleton is making an interlocking block from pumice supplied by the Volcanic Materials Co. The Pendleton Pumice Products Co. is using raw material from the same company.



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Wasco County. - Dant & Russell, Inc., of Portland is producing Dantore, its trade name for expanded perlite. The plant is near the Lady Frances mine at Frieda, south of Maupin. Some of the material was being shipped to an expansion plant at Grand Rapids, Mich. The freight-rate structure was too burdensome, and this operation stopped after about a year.

Harney County. - The Harney Concrete Tile Co. of Burns is producing pumice.

Malheur County. - The Idaho-Oregon Perlite Co. of Portland is developing a perlite property north of the Jordan Valley. The Northwest Development Co. of Portland is investigating a perlite deposit near Sheaville.

Klamath County. - The Perma-Insulating Co. and the Western Block Co., both of Portland, are using pumice from the Chrystallite Aggregate Co. of Chemult. Other producers are Boorman Pumice Product; Insulite Pumice Brick & Tile Co.; and Klamath Pumice Brick & Tile Co., all of Klamath Falls.

Other pumice-block producers include:

| | |
|---|---|
| Jackson County | - Crater Pumice Co., Phoenix |
| Jefferson County | - Pum-Brick Tile Co., Madras |
| Josephine County | - Pumice Block Plant, Grants Pass |
| Marion County | - Pumilite Concrete Block Co., Salem |

The Bristol Silica Co. is producing crushed granite from the Rogue River area of Josephine County.

Washington

(a) Dimension stone.

Granite occurrences are known in Pierce, King, Snohomish, Clark, Chelan, Okanogan, Ferry, Pend Oreille, Spokane, Whitman, and Yakima Counties.

Pierce County. - The Walker Cut Stone Co. is producing pulpstone, building stone, and split-face ashlar at its Wilkeson quarry. The Ashford and Kopawsin quarries have records of previous production.

King County. - Patrick O'Hara of North Bend is producing architectural and monumental granite from the Denny Creek area.

Snohomish County. - Hemphill Bros. of Seattle (formerly Hemphill & McKillop) is producing granodiorite from the Halford quarry. A deposit of chatoyant feldspar in the vicinity of Darrington has potential value as ornamental stone. The Index granite quarry produces dimension and crushed granite.

Clark County. - An ornamental stone is being produced at the Red Rock quarry near Camas. The Camas quarry has produced red basalt for use in the construction of a local church.



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Chelan County. - The Columbia Granite Co. is operating the Manson quarry, producing a dark-red granite.

Okanogan County. - The Columbia Granite Co. operates the Pateros Brewster and Methow River quarries.

Pend Oreille County. - The Bennion Colorok Co. of Spokane is producing flagstone and building stone.

Spokane County. - The Empire Granite Co. is producing monumental and architectural granite from its quarry near Dishman. Ray C. Keene & Son of Medical Lake is operating the Morris quarry. The Little Spokane River quarry is producing a granite building stone. The Washington Monumental & Cut Stone Co. is producing a light-gray granite. Former production has been reported from the Giles & Peat quarry and the Fairfield quarry.

Whitman County. - The Granite Point quarry is supplying granite for building and heavy masonry.

Asotin County. - The Grande Ronde quarry produces a dark-gray granodiorite suitable for building stone, but inaccessibility of the deposit is hampering development.

Yakima County. - A deposit of cleavable andesite suitable for flagstone, benches, and other decorative purposes occurs in the Mount Adams area, and a cleavable felsite is found along Clear Creek.

Widespread sandstone deposits occur in San Juan, Clallam, Kitsap, Grays Harbor, Pacific, Whatcom, Skagit, Snohomish, King, Pierce, Thurston, Lewis, Cowlitz, Skamania, Yakima, Kittitas, Chelan, Douglas, Benton, Ferry, Asotin, and Whitman Counties.

Only the quarries having production records will be listed here. For a more complete listing, see G. M. Valentine's Inventory of Washington Minerals, part I, Nonmetallic Minerals.

San Juan County. - The Sucia Island quarries have furnished paving blocks for use in Seattle and heavy masonry for the drydocks of Bremerton. The Alaska Barge quarry formerly produced Belgian blocks. The Reid Harbor quarries on Stuart Island produce building stone.

Clallam County. - The Port Angeles quarry 2 miles south of the city provided much of the building stone used locally.

King County. - Building stone was formerly produced at the Eureka (Cumberland) quarry.

Pierce County. - The capitol buildings in Olympia were constructed from stone produced from the Walker (Wilkeson) quarry. The Fairfax quarry also has produced.

Thurston County. - Building stone formerly was produced at the Hercules and Western quarries.



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Yakima County. - Ben Hanson of Independence, Oreg., is producing flagstone from the Sheet Rock quarry in the Mount Adams area. The Yakima quarry formerly furnished building stone.

Kittitas County. - Quarries in the Cle Elum area formerly furnished building stone for local use.

Benton County. - The Prosser quarry supplies stone for local buildings.

Ferry County. - The Wiseman-McGillis quarries furnish material for local building.

Asotin County. - The Clarkston quarry furnishes material for local building.

Whitman County. - The Hole in the Ground Quarry Co. of St. John is producing flagstone from the Rock Lake area.

Spokane County. - J. E. Hause is producing flagstone from the Fish Lake area.

Slate occurs in Skagit, Ferry, Whatcom, Snohomish, Stevens, and Pend Oreille Counties.

Skagit County. - A deposit near Sedro Wooley is used for riprap; exploration may indicate higher grade.

Snohomish County. - The Pilchuck River deposits have not been proved commercial, as yet.

Ferry County. - Deposits in the Stahley Mountain area are undeveloped but have commercial possibilities.

Stevens County. - Slate quarry produces material for roofing and milling. A deposit near Waits Lake has not been examined in detail.

Pend Oreille County. - Slate from the No Name Lake is used for sidewalks and decorative purposes. G. B. Deeble operates a quarry 2 miles from Boad Lake.

(b) Crushed stone.

Crushed stone is produced in Adams, Asotin, Benton, Cholan, Clallam, Clark, Columbia, Cowlitz, Douglas, Ferry, Franklin, Garfield, Grant, Grays Harbor, Jefferson, King, Kitsap, Kittitas, Lewis, Lincoln, Mason, Okanogan, Pacific, Pierce, Skamania, Spokane, Stevens, Thurston, Walla Walla, Whitman, and Yakima Counties.

In most instances only the quarry names will be listed.

Adams County. - Cunningham, Hatton, Elmore, Lind, Hill, Ritzville, Daughters, and Oestreich quarries.



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Asotin County. - Farrish, Benedict, and Hostettler quarries.

Benton County. - Reils and Rothrock quarries.

Chelan County. - The Sampson and Redman quarries are operating, and the Entiat quarry is operated by the Great Northern Railroad.

Clallam County. - Shotwell and Slater quarries.

Clark County. - Yacolt quarry.

Columbia County. - Hester, Barkley, and Delaney quarries.

Cowlitz County. - Kalama and Mount Coffin (Star Sand & Gravel) quarries.

Douglas County. - Hollingshead, Case, and Wagoner quarries.

Ferry County. - Republic and Devil's Elbow quarries.

Franklin County. - Mesa, Kuney, and Anderson quarries.

Garfield County. - Knettle, Cyrus, Alpowa Hill, Oliphant, Bartlow, and Pomeroy quarries.

Grant County. - Ephrata and Wilson Creek quarries.

Grays Harbor. - Arctic, Newskat (Quigg Bros. Construction Co.), and Hoquiam quarries.

Jefferson County. - Mats Mats quarry (General Construction Co.).

King County. - Riverton (Puget Sound Bridge & Dredging Co.), Black River, Baring (Hemphill Bros., Inc.), Mud Mountain, Landsburg, Eureka, and Snoqualmie quarries.

Kitsap County. - Charleston (Independent Asphalt Paving Co.), Wilson, Olsen, Reynolds, and Waterman quarries.

Kittitas County. - Regan, Dubinsky, Cooper, Adams, and Burcham quarries.

Lewis County. - Dean, Eveline, Sliwa, Coleman, Mullaney, Bunker, Meshill, Doty, Alpha, and Weyerhaeuser quarries.

Lincoln County. - Bonthins, McDade, Miller, Rothrock, Brown, Rockstool, Wilson, Jurgenson, Lauritzen, Alm, Mangis, Gale, Gerb, Kramer, and Pebles quarries.

Mason County. - Tuff quarry.

Okanogan County. - Wanconda quarry.

Pacific County. - Lane Creek, O'Conner Creek, Naselle River, Pluvius Nallpee, Falls Creek, Half Moon Creek, Johnson, and North Willapa River quarries.



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Pierce County. - Mashell River (Strong & McDonald) and Orting quarries.

Skamania. - Stevenson, Dietderick, Cooks, and Underwood quarries.

Snohomish County. - Index and Soderberg (Manufacturers Mineral Co. [Mineral Products Corp.]).

Spokane County. - Dishman (Empire Granite Co.) Weinandy, Dorsey, Fieser, Harris, Roberts, Wallace, Conrad, Mica, Green, Hansen, Bartlett, Mount Spokane, and Elk quarries.

Stevens County. - Springdale, Collins, Jeanneret, Rose, and China Bend quarries.

Thurston County. - Columbia and Webber quarries.

Walla Walla County. - Gummings, Lambdin, Moore, Davis, Dodd, and Mills quarries.

Whitman County. - Dahm, Collins, Jones, Druffel, Henderson, Sage, Bishop, Staley, Glaspy, Scholtz, Sanders, McNeilly, Chestnut, Coching, Palouse, Thompson, Greenwalt, Duffield Creek, Turnblow, Weitman, Garfield, Caksdale, Fish, and Murphy quarries.

Yakima County. - Union Gap, Ruddle, Zirkle, and Dog Lake quarries.

Pumice deposits are known in Chelan, Okanogan, Snohomish, Yakima, Skamania, Lewis, Douglas, and Grant counties.

Chelan County. - The B & K mine, Everett, is producing pumice in the Entiat district. Joe Scholze of Leavenworth is operating a deposit in the Chiwawa district. Arne Sorlie of Lakeside is operating in the Twenty-five Mile Creek area. Patty, Curtis, and W. Asher are also producing from the Entiat district. George Goman of Winesap is operating the Goman pit. Clarence Burney of Everett is operating the P & B mine (C & B pit). The Heller pit is operated by George Heller. C. A. Harris of Ardenvoir is operating the Harris pit. Jack Smart is operating his pit at Brief. W. Nichol of Entiat is operating the Nichol pit. Other producers include Patty Bros., Asher & Fouts, Big Six Pumice Mining Co., Butler Bros., L. A. Bortz, and Clifford Griffith.

Douglas County. - The Moses Coulee Pumice Co. of Wilson Creek is producing pumice in the Moses Coulee area. Cleo Hicks of Bridgeport is operating the Hicks pit.

Grant County. - The Hy-dry Insulation & Supply Co. is operating the Adrian deposit.

King County. - The Northwest Haydite Co. of Seattle is currently developing a pumice property near Woodinville.

Lewis County. - John Gaines and P. F. Hunt of Winlock are producing pumice from the Rundle area. The Rainier Pumice Co. of Auburn is producing from its Popcorn pit. The Insulrock Products Co. (Layrite Concrete Products) of Seattle



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is operating in the same vicinity. The Western Sales & Manufacturing Co. of Seattle is operating in the Randle-Kosmas area.

Okanogan County. - Mutual Industries, Ltd., of Tacoma is operating the Droughton pit.

Snohomish County. - The Unit Co., Inc., of Seattle is producing from the Darrington pit.

Yakima County. - The White Diamond Pumice Mining Co. of Sunnyside is operating the Zillah pit.

Pumicite occurrences are known in Skagit, Lewis, Chelan, Kittitas, Yakima, Grant, Benton, Franklin, Walla Walla, Columbia, Garfield, Asotin, Whitman, and Spokane Counties.

Asotin County. - Pumicite from the Dry Gulch deposit is used as building material in the Lewiston-Asotin area.

Spokane County. - Building Supplies, Inc., uses material from the Mead deposit for dusting brick molds. Frank Stanger is producing at Mead.

Skagit County. - The Rainier Pumice Co. of Auburn is producing from its pumicite pit in the vicinity of Marblemount.

Chelan County. - Many undeveloped deposits occur in this county.

Grant County. - A commercial deposit occurs 4 miles southeast of Beverly.

Yakima County. - Deposits occur in the northern part of the county and in the Yakima Valley between Sunnyside and Granger.

Benton County. - A deposit is known within the restricted area of the Hanford Engineering Works.

Snohomish County. - Whitechuck, Inc., is producing pumicite from the Darlington district.

Perlite occurs in Chelan, Klickitat, Pierce, Benton, Skamania, Yakima, King and Clark Counties.

Chelan County. - The Dry Gulch, Rooster Comb, and Crum Canyon deposits probably will be examined further.

Klickitat County. - A deposit of potential value occurs in the Yakima Indian Reservation 1-1/2 miles north of Indian Rock.

Pierce County - An occurrence, 10 miles east of Enumclaw and others at Cyclone Creek, Cliff, Divide, and Milky Creek have been reported.

Benton County. - A deposit at Prosser is being investigated.



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Skamania County. - An occurrence is reported at Gillott.

Yakima County. - The Peterson deposit is near the headwaters of the Klickitat River in the western part of the county.

Clark County. - A deposit is known near Crawford 20 miles northeast of Vancouver.

Idaho

(a) Dimension stone.

Feldspathic, arkosic, and tuffaceous rock deposits suitable for building purposes are known in Ada, Bear Lake, Cassia, Nez Perce, Butte, Valley, Lemhi, and Bonneville Counties.

Ada, Bear Lake, and Cassia Counties. - Sandstone deposits of fine quality for building stone are found in these counties. The stone was used for the State capitol and other large buildings in the State. The Boise Stone Co. has a large operation in Ada County.

Nez Perce County. - Marble and basalt suitable for building purposes have been produced. A church in Lewiston was made of the basalt rock.

Butte and Cassia Counties. - Marble has been exploited in the former county and is reported in the latter. A tremolite-limestone suitable for building is found in southern Cassia County.

Bonneville County. - A business building in Idaho Falls was built of basalt from the county.

Lemhi County. - A pink granite, found along the Middle Fork of the Salmon River, is striking in appearance but unfortunately is remote from transportation.

(b) Crushed stone.

Pumice or perlite has been reported in Owyhee, Butte, Madison, Power, Blaine, and Cassia Counties. No production data were found.

Montana

(a) Dimension stone.

Deposits of stone suitable for building purposes are known in Park, Broadwater, Fergus, Madison, and Big Horn Counties.

Park County. - The outstanding deposit of building stone in the State is near Gardiner. The Northwest Improvement Co. has quarried a beautiful travertine that has been used in many parts of the country for interior trim.



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Broadwater County. - The Vermont Marble Co. is operating the Black and Gold marble quarry near Radersberg.

Fergus County. - A resistant sandstone that is easy to cut is found a short distance east of Lewiston. Marble found in the Button Butte and Marble Mountain area near Lewiston is suitable for monumental or architectural stone.

Madison County. - The Montana Onyx Co. of Butte has a deposit of banded Montana onyx in the Stillwater district.

Big Horn County. - Small production of building stone for local use comes from the Amsden formation in the Big Horn Mountains southwest of Hardin.

(b) Crushed stone.

To date, true pumice has not been found in the State. Pumicite, however, occurs in many counties. Extensive deposits are known in Gallatin, Madison, and Rosebud Counties.

The grade usually is not high enough for abrasive purposes but could possibly be used for lightweight aggregate.

Rosebud County. - A deposit of fairly pure pumicite occurs 9 miles southeast of Hathaway.

## Talc

Talc is a hydrous magnesian silicate and the softest of all minerals. The pure, soft mineral in trade is called talc, but the term is used also to include steatite, a massive, compact variety, and soapstone, which consists essentially of talc but includes other minerals. Pyrophyllite is included sometimes improperly with talc because it is used for some of the same purposes.

The softness, flakiness, and stability of talc make it a desirable substance for many uses, among which are: As an extender in paint and as a pigment in cold-water paint; in ceramics ground talc is used to manufacture wall tile, electrical porcelain, dinnerware, artware, and high-frequency insulation; in cosmetics only the finest grades of talc are used for toilet powders, lotions, and face creams. Ground steatite-grade talc is being used as synthetic lava talc to supplement and replace natural block talc, which is limited in occurrence and costly to mine and machine. Other uses include: Roofing, paper, rubber, textiles, insecticides, as a lubricant in certain greases, in stove and auto polishes, and in floor wax.

### Oregon

Talc deposits have been reported in Douglas, Grant, Jackson, and Josephine Counties.

Douglas County. - Talc deposits are known 1.5 miles south of Canyonville, on Starveout Creek; 12 miles east of Azalea, near Tiller; 2 miles southeast of Milo; and on the Umpqua River northeast of Canyonville.



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Washington

Talc has been reported from Skagit, Chelan, Okanogan, Ferry, Stevens, Lincoln, and Benton Counties.

Skagit County. - The Skagit Talc Products Co. of Sedro Wooley is operating a deposit near Marblemount. It is a soapstone deposit with some intermixed high-grade talc. It is ground for use an an insecticide base and cut into dimension blocks for carving. Certain parts of the deposit yield material usable for steatite and lava purposes. A deposit at Alvard, recently operated by the Skagit Talc Products Co., is being leased by the Skagit Talc Products, Inc. The Skagit Puget Sound Talc Co. has the McMyrl-Wilson deposit under development. The deposit formerly supplied dimension soapstone for laboratory use.

Dad's Girl claim is being investigated by the same company. The Northwest Talc & Magnesium Co. is operating a deposit at Clear Lake. The high-grade talc is ground for agricultural purposes and as an insecticide diluent. The Londonderry Mines, Inc., recently has marketed a good grade of soapstone. The Wilson talc mine of Wenatchee is producing talc and soapstone from its deposit in the Skagit River area.

Chelan County. - Deposits that probably will be investigated include: Williams Creek, Entiat, Tumwater Canyon, Roaring Creek, and Lockwood, and Cole.

Lincoln County. - Talc from the Mondovi deposit formerly was ground and sent to paper mills. The Travis Farm deposit has not been examined in detail.

Ferry County. - An occurrence known as the Republic deposit has been reported.

Montana

Talc has been reported in Madison, Gallatin, Beaverhead, and Lewis and Clark Counties.

Beaverhead County. - Deposits east of Dillon: The largest production comes from the area of Axes Creek, 11 miles southeast of Dillon. The Tri-State Minerals Co. of Los Angeles, Calif., is operating the Smith-Dillon talc mine, an open-pit steatite deposit. Deposits at Carters Creek (Keystone mine) and Timber Gulch (Crescent mine) are being developed.

Madison County. - Deposits south of Ennis: The Montana Talc Mines property is up Johnny Gulch, 20 miles south of Ennis. Large quantities are known, but the long haul and rather low grade have restricted operations. During World War II, 30 to 40 carloads was shipped for ceramic, lava, and cosmetic uses. Small deposits are known also north of Virginia City up Granite Creek and southwest of Virginia City on Idaho Creek.

Lewis and Clark County. - Deposits south of Helena: A small deposit south of the Helena city limits has been mined out.



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The volume of easily available talc in Montana gives promise of a moderate permanent industry.

## Vermiculite

Vermiculite, a hydrous silicate of magnesium, iron, and aluminum, is an alteration product of biotite and phlogopite mica. The mineral has some of the properties of the micas in that it has perfect basal cleavage and splits readily into thin laminae, which are soft and pliable but inelastic. When heated it exfoliates by expanding at right angles to the cleavage into long, wormlike pieces (the name is from the Latin vermiculari - to breed worms). The expansion is thought to be caused by the contained water being converted to steam. Commercially prepared material increases 8 to 12 times in bulk volume, but individual flakes may expand more than this. There is virtually no use for the unexpanded material. It is shipped, however, in this form because the expanded material varies in weight from 4-1/2 to 10 pounds per cubic foot. In this way it can be shipped in concentrated form close to the market and then expanded.

The characteristics of expanded vermiculite that make it commercially useful are: Its thermal insulating qualities, lightweight, fireproofness, and granular form. The larger granules are used for loose fill insulation for homes, industrial structures, farm buildings, cold storage, refrigeration, high-temperature refractory surfaces, and all types of high-temperature and low-temperature industrial equipment. The medium-size granules are graded to make aggregate for insulating concrete and plaster. It is also used in horticultural work, where its properties of holding air and water make it useful for root development and for starting seed and cuttings. It is also used as an additive for conditioning soil. The Division of Industrial Research, Washington State College, at Pullman, is conducting research on the use of various minerals as soil conditioners.

Montana is the leading producer of vermiculite in the country and the only producer in the Pacific Northwest.

### Montana

Vermiculite deposits occur in Lincoln, Hill, Ravalli, and Madison Counties.

Lincoln County. - The Zonolite Co. of Chicago, Ill., the largest producer, is operating at Libby. (The Vermiculite-Northwest, Inc., of Spokane uses raw material from Libby and, after processing at Portland, Oreg., and Spokane, Wash., markets Zonolite and Terra-Lite for insulation. A similar plant is operated at Libby during the rush periods.)

Ravalli County. - The Vermiculite Corp. of America, Minneapolis, Minn., has an operation at Hamilton. The Girds Creek Vermiculite Products Co. of Hamilton is operating a deposit on Girds Creek. A deposit a few miles north of Pony is being developed.

Madison County. - The Gilliam mine in the Pony mining district is in standby condition. Plans are being formulated to build an expansion plant at Cardwell.

Hill County. - A deposit in the Bear Paw Mountains east of Big Sandy, probably will be examined further.



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